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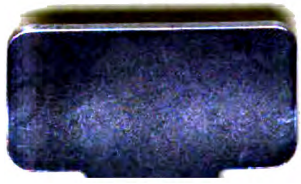

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MINUTES OF PROCEEDINGS

OF THE

ROYAL ARTILLERY INSTITUTION.

VOLUME II.

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Report of Ordnance Select Committee, No. 1404, January 26, 1861. Breaching experiment with smooth-bored guns against Martello Tower, No. 49, near Bexhill, Sussex. Communicated by direction of the Secretary of State for War 397

Annual Report and Abstract of Proceedings of a General Meeting of the R. A. Institution, held on Monday, May 13, 1861. Colonel Dick, R.A., in the Chair 415

*** NOTE.—*Plates for "Italian Campaign," bound separately.*

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WORKS ON ARTILLERY AND GUNNERY.

The following Chronological Catalogue of Works on the subjects of Artillery and Gunnery, and others nearly connected with the duties of the Artilleryman, was compiled by me three or four years ago, from various Catalogues: and is here printed in the hope that it may be found useful by those whose taste leads them to researches among the earlier records of our profession, a subject full of curious interest, and forming no unimportant a chapter in the history of the last three centuries. It is probably far from complete, as regards German and Italian Literature; but I think contains nearly all the English Books that are extant on these subjects, and it is gratifying to find that the Royal Artillery Library contains so many of them. There are also duplicates of many of them in the Library of the Regimental Institution. The Works that are in the former are distinguished by being printed on the outer line, like Agrippa "Trattato de Scientia d'Arme;" while those that are not at present in the Library are *indented, i.e.*, carried to the right; most of the latter are taken from the Catalogue which is to be found at the end of the *Aide-Memoire à l'usage des Officers d'Artillerie, &c.*, 1819, and from the *Bibliotheca Britannica*, the titles taken from the former are translations of the French titles there given, which are translations of the Latin, German, or Italian originals. To verify these would require a reference to each Work severally, which I have not had an opportunity of making.

The subjoined note may save a reference *

J. H. LEFROY,
Lieutenant-Colonel,
Royal Artillery.

November 16, 1857.

* *Art of Printing.*—The art of printing from blocks was probably practiced as early as the year 1430. *Cut* metal types were invented some time previous to 1450, for a Latin Bible was printed from them in that year, which must have required some years to execute. Types were *cast* about 1459, by Peter Schoeffer, the servant and son-in-law of Faust.

1457. There is a Codex Psalmorum in the Imperial Library at Vienna, bearing the date 1457, and this is said to be the most ancient book known to be printed with a date or inscription.
1459. Rationale Divinorum Officiorum. In Earl Pembroke's Library.
1462. Latin Bible. Royal Library, Paris.
1465-6. Tully's Offices. Bodleian, Corpus Christi, &c.
1471. Caxton's first publication in the English language. After this date books become commoner.

Printed books earlier than the year 1470 are extremely scarce.

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CATALOGUE.

1489. The Fayt of Armes and of Chivalrye, translated out of the French by William Caxton, a Compilation from Vegetius, and Others

1527. Albert Durer, unterricht von Befestigung du Stätte, Schlosse und Flecken. *Nurenburg.*

1530. Preussens (Germ.) Rank and Designation of all troops; species, name and number of all arms contained in an Arsenal, of every weight, calibre, &c.

1537. Tartaglia. La nova Scientia inventa. *Venice.*

1540. Beringuccio. Pirotechnia. On the art of improving the quality of Gunpowder, and casting metal for Canon, lator of Tartaglia's Latin Works into Italian.)

1546. Tartaglia. Quæsiti et inventioni diversi. *Venica.* *See* 1588.

1553. Agrippa. Trattato de Scientia d'Arme. *Roma.*

1554. Zanchi. On the mode of fortifying cities.

1557. Beroil de la Treille. Manière de Fortifier les villes et chateaux. *Lyon.*

„ Fronsberg. On Arms and Fireworks. Feux d'Artif.

1561. Schmidlap Fireworks. *Nuremburg.*

1564. Giacomo Cataneo. Fortification, Attack and Defence of Places, Position of Camps.

1566. Cantorio. Discorsi di Guerra.

1567. Dominica Mora. Tre quesiti in dialogo sopra il fare Batterie, Fortificare una Citta, &c. *Venise.*

1568. Ferretti. Osservanza Militare. *Venetia.*

1571. Cataneo. dell Arte Militare. *Brescia.*

„ „ il modo de Fortificare offendere, &c. *Brescia.*

„ „ nuevo Ragionamento del fabricare le Fortezze.

1572. Vegetius. de re Militare. Translated by J. Sadler. *London.*
Hero. de Machinis Bellicis. *Venetiis.*

1576. Martina (Ital.) Mines, Fireworks.

1577. Cataneo. The art of making Firearms, Arms, &c.

1578. Of the knowledge and conduct of Warres.

„ Bourne. Art of Shooting great Ordnance; reprinted 1643. *Royal Artillery Library has both Editions.*

Manus (Germ.) Artillery and Fireworks. *Dantzick.*

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1579. Leonard and Thos. Digges. Stratioticos, including a Treatise of Pyrotechnie and Great Artillerie. see 1590.
1581. Thos. Styward. Pathwaie to Martial Discipline in two Books.
1582. Rocca. Discorsi de Guerra. *Venetia.*
1582. Cataneo. Avertimenti et essamini interno a quelle chose che richiedono a un perfetto Bombardiero. *Vinegia.*
1584. Busca. Instruction des Bombardiers.
1587. Rich. Pathway to Military Practise. *London.*
1588. Machiaval. Arte of Warre, set forth in English by Peter Whitehorne. *London.* There are Editions of 1560 and 1573.
„ Tartaglia. Three books of Colloquies concerning the Arte of Shooting, translated by Cyprian Lucar, with the Lucar appendix, shewing the properties office and duties of a Gunner, &c., *See* 1537 and 1546.
„ Whitehorne. Certaine waies for the ordering of Soldiers in Battleray, &c. *London.*
„ Ramelli. On Sundry Ingenious Machines.
„ Cataneo. Briefe Tables for the forming a just Battaile, *London*
1590. Barrett. Theorike and Practike of Modern Warres.
„ Digges. Arte of Great Artillery.
„ Smythe. Discourses concerning the forms and effects of divers sorts of weapons, and of the great sufficiencie and excellencie of archers. *London.*
1591. Brechtel. Artillery and Fireworks. (Germ.)
„ Burger, (Germ.) Rules for loading, pointing, and firing great ordnance.
1592. Collado. Practical Manual of Artillery. *Milan.*
Gentiliani. Instruction for Bombardiers.
1593. Sutcliffe, the Practice, Proceedings, and Laws of Armes.
1594. Errard (de Bar le Duc.) la Fortification demontrée et reduit en Art. Editions 1600, 1604, and 1620.
1598. Boilot. Modelles, Artifices de Feu, et divers instr de guerre, avec les moyens de s'en prevaloir. *Chaumont.*
„ Busca. Instruttione di Bombardieri della expugnatione et difesa della Fortezza. *Torino.*
Capo Bianca, (Ital.) la Couronne et la palme Militaire de l'Artillerie. *Venise.*
„ Nouvelle Fortification. (Anon.)
„ Rojas. Theory and Practice of Fortification. *Madrid.*
1599. Blondel. Nouvelle maniere de fortifier les places.
„ Lipsius. Marchi della Architttatura Mil.
„ Gallé Table de la Portée des Canons.
1600. Smith's Art of Gunnery. *See* 1643.

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1601. Busca. Della Architectura Militare.
„ Tarducci, (Ital.) On Ancient and Modern Machines.
1602. Perret J. Fortification et Artifices. *Francfort.*
„ Oslandi, (Ital.) Instructions on Art., the Perfect Bomb.
1603. Clavius. Artifices and Machines.
„ Jacobi. On the Art of Mauufacturing Arms. (Germ.)
1604. Possevino. Il soldato Christiano con nuove aggiunte. *Venetia.*
1605. St. Julien. Architecture Militare.
„ Rivault de Flurance, des Elémens d'Artillerie.
1606. Gentilini. La real Instruttioni di Artiglieri. *Venetia.*
„ St. Julien. le Forge de Vulcain ou l'appareil des machines de guerre. *La Haye.*
„ Davilourt. L'Artillerie. *Paris.*
1608. Speckle. Architectura von Vestungen.
„ The exercise of arms for Caliures muskettes and pikes, from the Dutch of J. de Gheyn.
1610. Ezauville. Invention nouvelle des eperviers et globe de guerre.
„ Avelourt. The Arsenal and Magazine 1610-18-23.
1611. Christoval Lechuga. Discourses on Artillery.
„ Adriani Romani. Pyrotechnia.
1613. Ufano, D. On the use of Artillery. *Frankfort.* *See* 1630.
1616. Wilhausen on Artillery.
1618. Pietro Sardi. Courona Imperiale dell' Architectura Militare.
„ Stevin. Castrametation. *Leyden.*
„ „ New method of Fortification. *Leyden.*
„ Buhlen, (Germ. and Ital.) Book of Artillery. Various methods of casting and proving heavy ordnance.
1619. Kobel, (Germ.) Dissertation on Military Fireworks.
1620. Thibourel. Collection of various Military Engines.
„ Besolders. Dissertatiou on Mortars. (Latin.)
1621. Sardi, P. Artigliera. *Venetia.*
„ Ufano, D. Vraye instruction de l'Artillerie. *Zutphen.*
1622. Markham. Five Decades or Epistles of Warre. *London.*
1624. Schwachius. Discours sur l'Artillerie.
„ Speculum Belli Sacri.
1625. Hundius. Description of the general rules of Fortification and Artillery. (Flemish)
1626. Cooke. The character of Warre, or the image of Martial Discipline. *London.*
1627. Furtenbach. Halinitro Pyrobolia.
1628. Norton. The Gunner, shewing the whole practice of Artillery. *London.*
„ Cooke. The Prospective Glasse of Warre.

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1629. Malte. Treatise of Artillery and Fireworks.
1630. Hanzelet. Pyrotechnia.
Ufano. Archeley, das ist grüdlicher und eigentlicher Bericht von Geschütz und aller zugehör. *See* 1613.
1631. Sciaban. Il Bombardiero Veneto. *Venetia.*
Malte. Instructions *sur le fait* de l'Artillerie. *Paris.*
1633. Marolois. Ars muniendi sive Fortificationis.
1634. Gerard Barry. A discourse of Military Discipline. *Bruxelles.*
1635. Babington. Pyrotechnia, or a Discourse of Artificial Fireworks. *London.*
„ Freitag. l'Architecture Militaire, ou la Fort. Nouvelle. *Leyden.*
Furtenbach. Architectura Universalis. *See also* 1643.
1636. Kruger de directione tormentorum. *Wilna.*
„ „ Chemical Meditations on the Explosion of Powder. (Latin.)
1638. Galileo. Dialogues on Motion, propounding the Parabolic Theory.
1639. Du Praissac. The Art of Warre, translated by Jno. Cruso. *Cambridge.*
„ Ward. Animadversions of Warre, &c. *London.*
„ John Roberts. The Compleat Canonier, or the Gunner's Guide. Editions 1686 and 1762.
1640. Zonta. Il Capitain d'Artigliera. *Venetia.*
„ Monnaci. Collection of Instr. for Gunners.
„ Luteanus "sur l'invention de Michel Langrenus, (Mathematician to the King of Spain) d'une bouche à feu *(Trispherico)* lancent par des inflammations successives, trois Globes hors du même Tube," Sometimes called Puteanus.
„ Davison, (Latin.) Philosophical Pyrotechy.
„ le Chevalier de Ville. Fortifications. *Venetia,* 1666.
1641. Collado. On the Invention of Powder. (Spanish.)
„ Gentiliani. Practice of Artillery.
„ Hexham. The Principles of the Art Military, in three parts. The third part treats of "eight severall peeces of Ordnance, as also instructions for Canonieres." *London.*
1642. Freitag. Architectura Militaris nova et antiqua.
„ Munno. (Spanish.) Instructions on Artillery.
„ Hazarro da Isla. Treatise of Artillery. (Portuguese.)
„ Tirfino. The complete Artilleryman. (Spanish.)
1643. Norton. The Gunner's Dialogue and Art of Great Artillery. pp. 94.
„ Bourne. Art of Shooting Great Ordnance, reprint.

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1643. Smith. Art of Gunnery, with certain additions thereto, pp. 120.
Furtenbach. Nouvelle méthod de fabriquer les Armes.
1644. Cordo, T. (Spanish.) Lessons on Artillery.
„ Mersenna. Balistique et Théorie des Arms.
„ Torricelli. De motu Graviorum, et naturaliter Projectorum. *Florence.*
1645. Cellarius. Architectura Militaris. *Florence,* 1656.
„ Pagan Comte de. Fortification. English translation 1667.
„ Goldmann. (Dutch.) New Fortification.
1646. Eldred. The Gunner's Glasse. *London.*
„ Malthus. Pratique de la guerre, contentant l'usage de l'Artillerie.
1647. Dögen. Architectura Militaris Moderna. *Amstelodamum.*
„ Nat. Nye. The Art of Gunnery, also 1664 and 1670.
„ The true way to make all sorts of Gunpowder and Matches. *Anon.*
1648. Civil War in France.
1650. Siemenowicz Casr. Ars Magna Artilleriæ. *Amsterdam.* English translation, French 1651, German 1676.
„ Aubignac. Abrégè de toutes les Fortifications.
„ Lieut.-Colonel Elton's complete body of the Art Military, with the practical part of the Art of Gunnery, also 1668.
1656. Cellarius. Architecture Militaire.
„ Schreiber. (Germ.) Dissertation on the Armourer's Art., and on Fireworks.
1657. Schreiber. Fireworks and Introduction to Artillery.
„ Chevillard. l'æil du Canon, ou la mire, Francs.
„ Sylvius duc de Wurtenberg. New sorts of Fireworks.
1658. Glauber. Chemical Researches.
1660. Fortius. (Latin.) The Perfect Gunner.
1661. Fournier. Traite des Fortifications.
„ Barriffe. Military Discipline, or the young Artilleryman. *London.*
1664. Nye's Artillery.
1665. See the Philosophical Transactions.
1666. Chev. de Ville.
„ Schreiber. On Arms.
1667. Pagan Comte de. Fortification.
„ Experiments for improving the Art of Gunnery by Sir R. Murray. *See Phil. Trans.*
„ d'Auvrignac. Livre de toutes sortes de Fortifications. *Paris.*
„ Ruse. The strengthening of strongholds, translated from the Dutch by His Majesty's commands. *London.*
1669. Coehorn. Artillerie et Arsenaux.
Kostner's Elements of Artillery.
1670. Nye. Art of Gunnery. *London.*

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1671. Gamboa. Military Memoirs on the Management of Artillery, and on Metallurgy. (Spanish)
„ Crauach. Military Inventions. *Pyrotubig, &c.*
„ Capra. On Military Architecture.
1672. Venn. Military and Maritime Discipline.
„ Moretti. Trattato de l'Artiglieria. *See* 1683. *Brescia.*
„ Tacquet. Military Architecture, translated from the Latin by J. Lacy. *London.*
„ The Complete Gunner. *London.*
1674. Anderson, R. Genuine use and effects of the Gunne. *London.*
„ Goret. On Regular and Irregular Fortification. *Paris.*
1675. de la Fontaine. Devoirs des Officiers d'Artillerie.
„ Gaya. Treatise on Arms, Warlike Machines, &c.
1676 Binning. Light to the Art of Gunnery. also 1689.
1677. Orrery, Earl of. A Treatise of the Art of War.
„ Bissigheim. Short Instructions for Gunners. (German.)
„ Milliet. The Art of Attack and Defence. *Frankfort.*
1678. Rossetti. L'Art de Fortification à Rebours. *Turin.*
„ Gaya. The Art of War, and the way it is at present practiced in France. *London.*
1679. Mestro. Physical Treatise on Artillery. (German.)
„ Dietrick. Discourse on Artillery.
1680. Medrano. El Practico Artillero. *Brusselles.*
„ Augustin. Artifices de joie.
1681. Northon's Practice of Artillery.
„ Brink. Description of the Dutch Artillery.
1682. Braun. Novissimum fundamentum, et Praxis Artilleriæ. *Dantzic.*
„ Coehorn. The Fortification of the Pentagon. *Sewarden.*
1683. Moore. Treatise on Artillery.
„ Blondel. l'Art de jetter les Bombes. *Paris.*
„ Moretti. General Treatise of Artillery translated, with some Notes thereon, and some additions for Sea Gunners, by Sir Jonas Moore, together with an Appendix of Artificial Fireworks, by Sir Abraham Dager. *London.*
1684. Mallet. Les Travaux de Mars. *Paris.*
„ Miet. On Artillery. In Four Parts.
„ Dr. E. Halley, on the effect of Gravity in Gunnery. *See Phil. Trans.* 1684 and 1686.
1685. Buchner. Theory and Practice of Artillery.
„ Catherinot. Treatise on Artillery.
" Euguenins. Armorer's Manual.
1686. Hawksbee on Gunpowder.
1686. Martinet. The Scourge of War. *Naples.*

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1687. The *Principia* of Newton published. *See* Lib. ii. for the Doctrine of Projectiles.
1688. A Treatise of Fortification and Military Discipline. *London.*
„ Wickrath. Collections of Artillery.
„ Sardi. On Offensive Arms, and Ancient Machines.
1689. Binning translated. *See* 1676.
„ Cambray. Maniere de fortifier par Vauban.
1690. Practique des Fortification.
„ Defer. Introd. á la Fortification.
„ Anderson, R. To hit a mark. *London.*
„ Gauthier. Treatise on Artillery Ranges, Constructions, &c.
„ The Perfection of Military Discipline, with the Art of Gunnery. *London.*
„ Anderson R. Proposals for the improvement of Great Artillery.
„ Anderson R. On the nature and use of Rockets.
1693. Marteno il Flagello Militare. *Napoli.*
Endel. The Armourer's Manual.
1695. Nodin, L'ingeneur, Francaie. *Lyon.*
Morasca P. On the Dimensions of the Three Descriptions of Artillery.
1697. Suriney de St. Remy. Memoires de l'Artillerie. *Paris.*
1698. Bernouilli sur la trajectoire dans l'air.
Pfeffinger, Fortification nouvelle. *La Haye.*
Winter. On Gunpowder. (Latin.)
1699. Coehorn. Instruction approfondie de l'Artillerie.

LIST OF THE PRINCIPAL ENGLISH WORKS ON GUNNERY AND FORTIFICATION, CONTINUED TO THE END OF THE 18TH CENTURY.

1703. Sir Jonas Moore. Modern Fortification. *London.*
1705. Savery. The new method of Fortification, by Coehorn, transl. from the Dutch. *London.*
1707. Barker. The Treasury of Fortification. *London.*
1729. G. Shelvocke. The Great Art of Artillery, translated from the French of Casimir Siemienowicz. *London.*
1731. J. Gray, F.R.S. A Treatise of Gunnery. *London.*

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1733. Wm. Sterrat. The Doctrine of Projectiles, demonstrated and applied to all the most useful Problems in Practical Gunnery. *Dublin.*

1742. BENJAMIN ROBINS. New Principles of Gunnery. 2nd edit. 1761. *London.*

1743. Wm. Macbean. The Constitution of Gunnery by way of Question and Answer.

1744. Lens. The Grenadiers Exercise of the Grenado in H.M. 1st Regiment of Foot Guards.

1746. *Anon.* A Treatise of Artillery, transl. from the French of Le Blond. *London.*

1748. *Anon.* The New Method of Fortification of M. de Vauban: with a Treatise of Military Orders and of Gunnery.

„ Dinsdale. The Art of Fortification delineated, from the French of Buchotte. *London.*

„ T. Simpson. The Motion of Projectiles near the Earth's Surface, considered independent of the Properties of the Conic Sections. *See Phil. Trans.*

1756. Molyneux. The Target; or a Treatise upon a branch of the Art Military. *London.*

„ Manningham. On Mines, from St. Remi; to which is prefixed Belidor's Dissertation on the Force and Effects of Gunpowder. *London.*

„ Fr. Holliday. An Easy Introduction to Practical Gunnery, or the Art of Engineering.

1757. J. Muller. A Treatise of Artillery for the use of the R. M. Academy, Woolwich, also 1780.

1759. *Anon.* The Military Engineer, from the French of le Blond. *London.*

1760. Count D'Arcy. An Essay on Artillery.

1763. Robson. The British Mars, containing several schemes and inventions to be practised by land or sea against an enemy. *London.*

1764. Le Blond. Treatise of Artillery, transl. *London.*

1765. Lieut. Jones, R.A. A New Treatise on Artificial Fireworks. *London.*

1766. Lieut. E. Williams, R.A. The Theoryand Practice of Gunnery, with Remarks on Belidor. *London.*

1767. Regulations to be observed by the Battalion Guns at a Review before His Majesty.

„ J. Muller. Supplement to the Treatise of Artillery. *London.*

1772. Ardesoif. An Introduction to Marine Artillery and Gunnery. *Gosport.*

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1776. Dr. Lind. Description of Rifled Ordnance. *Edinburgh.*
„ J. Glenie, M.A. The History of Gunnery. *Edinburgh.*
1777. Hugh Brown. The True Principles of Gunnery, with translations of Eulers Observations on B. Robins.
1778. Pringle. A Discourse on the Theory of Gunnery, *delivered before the Royal Society.* London.
„ Hutton. On the Force of Fired Gunpowder, and the Initial Velocity of Cannon Balls, determined by experiment. *London.*
1779. Burrow. An Essay on the Theory of Gunnery, or the doctrine of Projectiles in a non-resisting Medium. *London.*
1786. Hutton. New Experiments in Artillery, 1783-1786. *Vide* Hutton's Mathematical Tracts, No. 9.
1789. Captain H. T. Thompson, R.A., translation of d'Antoni on Gunpowder and Firearms, and on the service of Artillery in time of War. *London, id.*
1795. Bolton. Remarks on the present defective State of Firearms. *London.*
1802. Count Rumford, (B. Thompson). Experiments to determine the Velocity of Projectiles and the Force of Gunpowder, &c. *London.*

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Note on Mortar Practice,

By Lieut.-Colonel Lefroy, R.A., F.R.S.

The completion of that astonishing achievement of mechanical skill, the thirty-six inch Mortar of Mr. Mallet, will naturally suggest to the mind of the Artilleryman, the question how far the irregularities incident to mortar practice are likely to be reduced by the employment of shells so far exceeding in weight any projectile heretofore employed in warfare. The mean weight of these 36-inch shells loaded may be taken at 26 cwt., or 2900 lbs., that of the 13-inch shell loaded being only 204·5 lbs., and with equal velocities the momentum will be as these numbers respectively, or as 14 to 1, whereas the irregularities due to atmospheric resistance will be only as the square of the diameters, or as 8 to 1 nearly, and a further reduction of uncertainty will result from the greatly reduced windage of the larger shell, which is about 0·225 inch, or 0·006 of the diameter, whereas that of the 13-inch shell is 0·160 inch, or 0·012 diameter. We may therefore with reason expect, in addition to an explosive and crushing effect as yet unknown, a far greater accuracy of fire than Mortars have generally afforded, but before an opinion can be formed on this question, we must know with some precision what we have been in the habit of effecting with the Mortars heretofore employed, and I venture in this note to submit some data collected long since, which may have the effect of inducing other Officers to pursue the enquiry, even if they prove of little value in themselves. My data are derived from the mortar practice on Woolwich Common in 1835, 1836, 1837, which I transcribed and reduced; none but re-stoved powder was used at that time, its strength by the Pendulum Eprouvette ranging from 19°·71 to 21°·70 for 2 oz. charges. This is a variation not exceeding what the best descriptions of large grained powder are subject to, when tested by the same defective instrument. Thus we have in the admirable experiments of Captain Mordecai, U. S A. in 1844, variations as follows in the strength of cannon powder:—

Mark	A.	Powder from Dupont's Mills, Delaware,	18°·25 to 22°·0.
,,	E.	,, ,, ,,	20°·09 to 21°·85.
,,	F.	,, ,, ,,	22°·04 to 23°·78.
,,	B.	,, from Garesché, Eden Park, Delaware,	19°·75 to 22°·67.
,,	C.	,, from Loonie's Mills, Connecticut,	18°·37 to 22°·27.
,,	D.	,, from Master's & Co., New York.	18°·83 to 22°·77.
,,	H.	,, Waltham Abbey, 1812,	22°·13.
,,		,, Waltham Abbey, 1838,	21°·97.
,,		,, French Cannon Powder,	23°·13.

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And Captain Mordecai arrives at the conclusion that these Eprouvettes "are entirely useless as instruments for testing the relative projectile force of different kinds of powder, when employed in large charges in a cannon; powders of little density or of fine grain, which burn most rapidly, give the highest proof with the eprouvettes, whilst the reverse is nearly true with cannon." The comparison, however, may serve to show that if somewhat weaker than new powder, or powder which has not been subjected to damp, and to the process of re-stoving, the irregularities of practice to be observed below are not attributable to greater irregularity of strength than that of new powder, nor would they, under any circumstances, affect the lateral deviation.

Only three ranges were in use, viz.: 600, 650, and 700 yards. One hundred rounds with each Mortar were abstracted for 600 yards, fifty rounds for the 13-inch mortar, and one hundred for the 10-inch and 8-inch, at 650 and 700 yards. Three rounds however of the 8-inch mortar at 700 yards were so wild that they were rejected, leaving only ninety-seven available. The following table contains the result; all the shells which fell over or under, or right or left of the flagstaff being separately summed up.

TABLE I.

Results of Mortar Practice at Woolwich, 1835-6-7.

Mortar.	No. of Rounds.	Errors of Range.				Errors of Directions.			Percentage falling				
		Extreme.		Mean.		Extreme.		Mean.	In the line of fire.	Within a radius of			
		+	—	+	—	Right.	Left.			10 ft	20 ft	30 ft	40 ft
Inch.		yds.	yds.	yds.	yds.	yds.	yds.	feet.					
		Given Range 600 yards.											
13	100	150	70	32	36	29	121	28	11	3	6	10	16
10	100	180	106	42	33	51	40	30	5	1	2	10	17
8	100	175	100	56	43	45	32	28	4	0	1	3	8
		Given Range 650 yards.											
13	50	100	75	31	33	25	21	22	4	2	8	10	20
10	100	156	108	50	25	46	50	38	6	2	5	5	6
8	100	220	80	55	30	45	42	41	0	0	1	4	11
		Given Range 700 yards.											
13	50	100	28	33	11	90	30	40	2	2	2	8	18
10	100	200	108	57	31	54	55	34	7	3	3	9	19
8	97	180	20	71	11	54	50	44	4	0	0	3	8

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Thus it appears that having a measured distance of 700 yards, it would have been necessary to fire 247 shells to ensure 5 of them falling into a space of 40 feet diameter.

The space within which one-half of all the shells fell were as follows:

	600 yards.	650 yards.	700 yards.
13-inch Mortar,	70 by 24 yards.	80 by 35 yards.	100 by 32 yards.
10-inch Mortar,	68 by 24 „	*	88 by 32 „
10-inch Mortar,	100 by 32 „	*	170 by 48 „
The whole,	79 by 16 „	100 by 36 „	120 by 40 „

It cannot be denied that this is a very unsatisfactory practice; something may doubtless have been attributable to the circumstance that it was carried on for instruction, not for experiment; but the pointing of a mortar is so simple that no great skill is required, moreover, all pieces are verified by an Officer before they are fired. The only consolation is that other Artilleries seem to succeed but little better. Thus the French consider (*Aide-Memoire* 1836,) that with the best directed fire it cannot be reckoned that more than ten per cent. of shells will fall within a circle of 10·5 feet radius at 650 yards, (600 mètres) while the Swiss *Aide-Memoire*, more precisely, gives the following percentage for a circle of 12·75 feet radius (12 feet French.)

At 650 yards.	At 505 yards.
8-inch Mortar 3·3 per cent.	3·5 per cent.
10-inch Mortar 3·3 per cent.	3·5 per cent.
13-inch Mortar 0·7 per cent.	1·6 per cent.

However, these are both sensibly larger proportions than the present comparison affords for English practice; and we have also proof that our own was formerly more regular. Among the interesting Records of the Military Society which was formed in the Regiment in 1771, and which are now in the possession of the Regimental Institution, there is a paper by Captain Alexander Jardine, dated 1775, in which he gives the results of Mortar practice for the four or five previous years at Gibraltar. He found that one-half of the shells fell within the following spaces:—

Between 900 and 1000 yards a space of 50 by 100 yards.
„ 600 and 700 „ „ 30 by 58 „
„ 400 and 500 „ „ 15 by 30 „

and adds the just remark " this may surely be taken as the utmost that can be done on Service, where we cannot be expected to weigh the

* These places are blank in the original note.

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charges, or point more accurately than at practice." The Mortars of that period were of brass, of the following dimensions:—

	13-inch.	10-inch.	8-inch.
Length of Chase,	24·0 inch.	18·0 inch.	13·0 inch.
Length of Chamber,	12 inch.	7·8 inch.	7·75 inch.
Weight,	25 cwt.	10·5 cwt.	4·25 cwt.
Shell filled,	193 lbs.	86 lbs.	45 lbs.

The length of chase in the above patterns is longer than in the recent Mortars, which have the following corresponding dimensions:—

	13-inch.	10-inch.		8-inch.	
		Old.	New.	Old.	New.
Length of Chase,	18·50 in.	9·2 in.	14·2 in.	7·2 in.	12·0 in.
Length of Chamber,	14·00 in.	10·8 in.	10·8 in.	8·8 in.	8·75 in.

The subject seems to deserve more attention than it has received, and would probably repay the trouble any Officer might take in reducing from the practice lobby books, the results of some more recent years, but I must forewarn him that unless they are much improved in accuracy, he must be careful to examine the figures.

26th October, 1857.

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The "Moolk-e-Maedan."

COMMUNICATED BY LIEUT.-COLONEL LEFROY, R.A., F.R.S.

The following letter was addressed to the late Colonel Sir Augustus Frazer, R.A., by Major Moor, relative to the celebrated Moolk-e-Maedan, or "Master of the Field," the great gun of Beejapoor, the dimensions of which are stated by Mr. Mallet, in his work on the Physical conditions involved in the construction of Artillery, (p. 192,) to be as follows:

	ft.	in.		ft.	in.
Length,.....	14	3.	Diameter at Breech,.....	4	10·5.
Calibre,.....	2	4.	Diameter at Muzzle,.....	4	8.

Major Moor gives some particulars not noticed by Mr. Mallet, which are of sufficient interest to deserve preservation. A model of this Gun will be found in the Royal Military Repository, No. 161 of the Catalogue.

(Copy.)

Letter from Major Moor to Colonel Frazer.

Dean's Yard, Westminster,
3rd May, 1834.

My Dear Frazer,

On the other side is a translation of the Persian inscription on the Beejapoor Gun. I wrote it on the day I left you. I have since received the impressions of that and other inscriptions on the Beejapoor and Agra Guns—of which I will hereafter send you translations; being mostly in very cramp Arabic, they require more and further looking at.

Pray thank the intelligent little gentleman of the Repository, (*the late Mr. Flaherty*) whose name I have forgotten, for the said inscriptions.

That on the model of the Beejapoor Gun does not accord exactly with my copy made on the spot, of that something farther, perhaps hereafter.

Yours, &c.,
C. MOOR.

"The inscription nearest the muzzle of the Beejapoor Gun may be thus translated":—

"Alum Geer, the victorious King, the refuge of the Faith, conquered Beejapoor in the 30th year of his auspicious reign.

The restorer of Justice, the conqueror of Kings, destiny smiled on him and exclaimed "he has won the Master of the Field." The last sentence is said to contain the date, 1097 of the Hegira, or Mahomedan era—1685 A.D. The Gun is extensively known by the name of "*Moolk-e-Maedan.*"

April, 1858.

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But the Gun is said to be older; and to have been cast for another dynasty—Nizam Shahy of Ahmednugger—and to have fallen into the hands of Sultan Mahomed, of the Adel Shahy dynasty—of Beejapore, who caused an inscription to be put on it to this effect—" The victorious Sultan Mahomed, in splendour like the Sun, under whose shade the world sought shelter, by the flash of his all-destroying sabre, in half the twinkling of an eye, captured from Nizam Shah, " *Moolk-e-Maedan.*" This is said to have been erased by Alum Geer (the name assumed with sovereignty by Aurung-Zeb), and the present inscription substituted. He conquered the empire of Beejapore from Sekander, the last of the Adel Shahy dynasty.

The form of this Gun, which is almost cylindrical, as compared with that of the Bhurtpore Gun, which is known to have been cast for Aurung-Zeb in 1677, appears to indicate the higher antiquity attributed to it by Major Moor in the above remark.

Having referred above to Mr. Mallet's great work, I am tempted to add another note. That gentleman gives the following description of the enormous Guns in use at very early periods by the Turks. " At periods," he says " anterior to the casting of bronze Guns in Europe, cannon of enormous magnitude appear to have been cast in India by the Arabs and Turks. Colonel Symes mentions a Gun at Arracan, captured from the Burmese, 30 feet in length, 10 inches calibre, and 2½ feet across the muzzle, which bore the appearance of great antiquity.

The Indian Guns, however, of which I have ascertained the dates, are of a later period.

The great bombard mentioned in the text (and by Gibbon " Decline and Fall," vol. xii., p. 197,) as cast for the Siege of Constantinople by the Turks, is stated elsewhere to have thrown a stone shot of 600 lbs. weight. This would agree better with 11 palms circumference of the shot, than 11 palms caliber, as stated by Gibbon and others, and coincide pretty well with the Guns brought by Mustapha against Malta, of 200 to 300 lbs., and with those now at the Castles of the Dardanelles, which are probably of a not much later epoch. Of these Bishop Pococke, in his travels in the East gives the following account:—

" Guns at the Natoli Eski Hirsar—Fourteen Guns of brass without carriages, loaded with stone balls, eight others towards the south, two very fine ones amongst them, one 25 feet long adorned with *fleur-de-lis* which they say was a distinction used by the Emperors of the East, before the French took these arms, and I have seen them in many parts." Is it not more likely that these Guns were captured from some of the orders of christian knighthood at Malta or Rhodes?

" The other is 20 feet long, in two parts after the old way of working cannon of iron in several pieces. The bore of this is two feet, so that a man may sit in it: 2½ quintals of powder are required to load it, and it carries a ball of 14 quintals."

This would be about the weight of 2000 or 2500 lbs. for a stone shot of that diameter.

" At the New Castle in Asia, near the mouth of the Scamander, are some very fine brass cannon. The bores not less than one foot in

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diameter. There are 21 of these to the southwest, and 29 to the northwest.

These Guns have also been described by Baron de Tott, but the most interesting account of them that I have met with, is that of Baron Von Moltke, Major in the Prussian Service, in his work the "Russian Campaign in Bulgaria and Roumelia in 1828-29," p. 528. "The batteries on the Dardanelles, contain one hundred and eight 44-pounders, nineteen 60-pounders, thirty 121-pounders, throwing iron balls, besides 63 Kemerlicks, or Guns which throw stone balls, some of which are 1570 lbs. weight. These gigantic Guns some of them are 28 inches in diameter, and a man may creep into them up to the breech. They lie on the ground on sleepers of oak instead of gun-carriages, with their butts against strong walls, so as to prevent the recoil, as it would be impossible to run them forward again in action.* Some of them are loaded with as much as 1 cwt of powder.

"Baron de Tott gives a somewhat high-flown description of the "earthquakes" produced by their discharge. In the most of them the touch-holes are as large as the barrel of a musket, the great mass of powder ignites slowly, and a good deal of it is always blown out of the mouth.

"The report is very violent, but dead, and is not nearly so painful to the ear as that of an 18-pounder in a casemate.

"It is easy to follow the ball, blackened with powder, with the eye, and it is frequently seen to split into two or more pieces. Huge jets of water are thrown up when it strikes the surface of the sea, as the ball fired off in Europe, slowly ricochets across the water till it reaches the Asiatic shore.

"These giant cannons of the Dardanelles have this disadvantage, that they can only fire straight before them, and that they take very long to load, but then the effect of a single ball that does hit is tremendous.

"When Admiral Duckworth sailed through the Straits in 1807, all the preparations for defence were of the most wretched description, nevertheless his fleet suffered considerable injury, especially from the Kemerlicks, a granite ball of 800 lbs. weight, 2 feet 2 inches in diameter, to the great astonishment of the sailors, broke through the whole *bed for the anchor* (carried away the bitts probably?) on board the "Active," and after crushing this mass of strong timber, rolled slowly across the deck.

"Another ball carried away the wheel of the Republic, and killed or wounded twenty-four men.

"The mainmast of the Wyndham was carried away, and the forecastle of the Royal George, a 110 gun-ship, was shattered by a single ball, so that she was near sinking, and could only be saved by very great exertions. Our readers, are no doubt, aware that in sea-fights, the holes made by the cannon-balls below the ships' water-line are plugged by men appointed, with conical pieces of wood to prevent the water from pouring in, but it would manifestly be impossible to plug a hole 2½ feet in diameter."

I had the good fortune in December, 1855, to visit the Castle of Asia

* This is no longer the case, they are very ingeniously mounted on huge carriages, the work of a Prussian Artilleryman.—J. H. L.

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at the Dardanelles in company with Mr. Calvert the British Consul, and ascertained with his assistance the dates of some of the most remarkable of these great brass Guns, which are clearly inscribed on them in Turkish numerals. There are several inscriptions upon them, both in Turkish and Arabic, but from the intricate contractions employed, they are by no means easy of decypherment, even to so accomplished a linguist as that gentleman. The oldest Gun observed was about 11 feet long, calibre not noted; it bore the date 862 Hegira, or A.D. 1456, and the name of the maker in Arabic; the metal was about 4 inches thick at the muzzle. Another is dated the 17th year of the Sultan Mahomed, or A.D. 1470. The calibre of this piece is about 24 inches. I was able easily to creep into it on hands and knees, fired by emulation to follow the example of a noble Duke who had previously performed the same feat. It is about 16 feet long, and affords a very remarkable example of mechanical skill in the Turks, or perhaps in their Genoese or Venetian workmen; it was cast in two parts, which screw together, about the place of the trunnions; the junction is not very close, but when we consider the difficulty of cutting a screw of more than 3 feet in diameter, and of afterwards screwing together two such enormous and unwieldy masses, the achievement conveys a very high idea of the ingenuity and boldness of the projectors.

There are two more Guns bearing inscriptions which state that they were brought from Bagdad in the year of the Hegira 1126, or A.D. 1720, and which bear the date 927 Hegira, or A.D. 1521. They seem to be fellows. The inscription on one of them states that it weighs 300 cantars, nearly 16·4 tons, it is 14 feet long, calibre about 26 inches, the weight of the stone shot is 5 cantars, or about 620 lbs., and the charge by the old inscription is 20 okes or 55 lbs., a more modern inscription or memorandum, says the ball weighs 240 okes, which would be rather more than 5 cantars, or about 660 lbs., and that the charge is 17·5 okes or 48 lbs.; it has been recently fired with 16 okes or 44 lbs., no contemptible trial of the work of the old engineers; as the touch-hole however would easily take ones thumb, this would diminish the effect of the charge. There is an inscription which says "the elevation of this Gun ought to be 7°" probably to command mid channel. It is heavily marked by Sir John Duckworth's shot.

The Turks attach no particular value to these Guns on account of their antiquity, having broken up and melted several of the same nature during the war, and these too doubtless at no distant day will follow the same fate. It is much to be wished that one of them should be procured, as a curiosity quite as worthy of preservation as a mutilated statue or piece of sculpture, the ordinary antiquarian imports from Asia Minor. The late Government actually took some steps in this matter, but their object being perhaps misunderstood, they led only to an acquisition of much less interest, in an antiquarian point of view.

March 6, 1858.

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Memorandum on Shrapnel Shells, drawn up by
COLONEL PICKERING, Royal Artillery,
for the Select Committee.

The frequent failures that had previously taken place in firing Shrapnel Shells at home and abroad, led to a series of experiments in 1852, at Shoeburyness.

The principal points to be determined by these experiments, as stated in the programme, were:—

1st. The causes of premature explosions.
2nd. The causes of the shells not bursting.
3rd. The remedies to be applied.

The Guns used were the following, viz.:—

Iron.	*Brass.*
8-Inch Gun.	12-Pr. Gun.
32-Pr. Gun.	9-Pr. Gun.
24-Pr. Gun.	6-Pr. Gun.
8-Inch Howitzer.	32-Pr. Howitzer.
	24-Pr. Howitzer.
	12-Pr. Howitzer.

The Fuzes were:—Old Fuzes with old priming; old Fuzes with new priming, and new Fuzes.

The Shells were also of various patterns, viz.:—

Those with fuze holes having the smooth lip, the screw lip, and the fuze hole without projecting lip.

The results were as follows:—

511	Good.
108	Blind.
37	Burst at Muzzle.
656	

The blind shells were nearly all recovered.

The priming of the fuzes was burnt, but the fuze composition had not ignited.

The quick match of the fuze was then fastened (at the Royal Laboratory) more securely, so that it should not be blown away.

There was still one blind shell out of six from the same cause.

Thirty shells were then fired with fuzes primed, according to Captain Boxer's method, *and all were good.*

The practice was repeated in 1853, with fuzes prepared:—

1st. By passing the point of a brass pricker through the priming, and scraping the surface of the fuze composition.

2nd. With fuzes primed according to Captain Boxer's method, *i.e.*, by boring a hole through the priming, and $\frac{1}{10}$th of an inch into the fuze composition.

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The first method did not succeed, the second succeeded most satisfactorily. The premature bursts were more frequent than in 1852.

The shells were fired generally in the state in which they were issued at Woolwich, without having been emptied and cleaned at Shoeburyness, as was done in 1852.

For the bursts at the muzzle various causes were assigned, and although in some instances they appear to proceed from a defective shell, an irregular fuze hole, or a bad fuze, no satisfactory conclusion could be formed.

Smaller charges were tried, and as might be expected, with somewhat improved results, still it was left uncertain, whether the evil was caused by the uneven thickness, or other defects of the shell, or by the ignition of the bursting powder from the friction of the balls within the shell.

General Shrapnel, many years ago, arrived at this latter conclusion, viz., that the ignition of the bursting powder was sometimes caused by the reaction of the balls on the inside of the shell.

He found that powder placed in the hollow of a broken 8-inch Shell, could be ignited by a lead ball fired from a musket at a distance of 30 or 40 yards, and that the same effect was produced when the broken shell was lined with lead $\frac{1}{2}$ or $\frac{3}{4}$ of an inch in thickness.

But it does not appear that General Shrapnel used any means to separate the powder from the balls except by driving the latter tight, and then removing a few near the fuze hole to make a space for the bursting powder.

This reduced the number of bursts at the muzzle.

Captain Boxer's Shrapnel Shells and Fuzes.

Captain Boxer's Fuzes not being adapted to the Shells of the service, none were tried in the foregoing experiments, but the reaction of the musket balls in the shell having been considered likely to loosen or drive out the fuze on the discharge of the gun, especially from shells without any projecting lip, and thus be one cause of premature explosions, some Shrapnel Shells, were made with a deep lip in 1852, according to a pattern furnished by Captain Boxer, and adapted to his fuze, which was thus protected from liability to accidents of this kind.

The practice with Captain Boxer's lipped Shrapnel Shells and Fuzes was very good, comparatively few premature bursts, and no failure of ignition of the fuze composition, so far as could be ascertained.

253 Good.
7 Blind.
13 Burst at Muzzle.

Eight of those which burst at the muzzle were among the first fired. A defect in their construction having been detected, was remedied on the spot by Captain Boxer.

With respect to the Blind Shells, Lieut.-Colonel Robe, who conducted the practice, reported as follows :—

"The mode of priming the fuzes, proposed by Captain Boxer, appears to answer perfectly, there not having been any instance of failure in the bursting of the shell, which could be traced to the non-ignition of the fuze; the only cases when the shells had not burst were proved to have been either caused

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by the extinguishing of the fuze, by grazing in water, or the fuze was entirely out of the shell when picked up, and consequently the cause of failure was undiscoverable. In one instance the fuze proved not to have been pierced, and therefore could not have fired the shell."

The state of the Shrapnel Shells in store at Woolwich having been carefully examined by the Inspector of Artillery, and his opinion as to the efficiency of a great number of them having been unfavorable, reports having also come from out-stations at home and abroad of an increased number of failures in practice, it was recommended that Shrapnel Shells and Fuzes required to be provided for 1853, should be of Boxer's pattern.

Various modifications in the construction of his fuzes were proposed, but in consequence of failure at the beginning of the trial, there has not been time to try all of them.

The experiments with these shells and fuzes have been, this year, very unsatisfactory. The failures were at first attributed to the fuzes, and slight alterations were made, but without the desired effect.

In order to adapt the Shrapnel Shells of the service to Captain Boxer's Fuze, 50 were fitted with gun metal bouches, and they were fired at Shoeburyness.

The result was unsatisfactory, though it is by no means certain that the bouching was the cause, for the premature bursts were equally frequent in firing other shells, and all may have proceeded from the same cause, viz.: the ignition of the bursting powder by the friction of the balls, and this is rendered more probable by the result of practice with plugged shells, both of Boxer's pattern, and of others cast for the East India Company. Fifty were fired containing balls, without bursting powder, and all were good.

Fifty were fired containing balls and bursting powder, and 17 burst at the muzzle.

It would appear from this experiment that 34 per cent. of premature explosion may sometimes be attributable to the contact of the lead balls and bursting powder.

Some of Captain Boxer's Shells on being recovered, after having been fired, were found to be without fuzes, this happened less frequently when the fuze holes were roughed; it was probably caused by the projecting head of the fuze being struck in ricochetting.

The bits used for boring into the side holes of Boxer's Fuzes, were found to be frequently broken, they require to be made of superior metal.

Captain Siemens' Hanoverian Shrapnel Shells and Fuzes.

The balls were fixed in these shells by means of sulphur, a cylindrical space being left under the fuzes for the insertion of the bursting power. The shells are carried in the gun limbers loaded, and with the fuzes fixed.

Captain Siemens took great pains with the timing or boring into the fuzes, an operation which requires great care.

The practice was very satisfactory at Shoeburyness in 1853. There were no premature bursts, and only 3 blind shells out of 100.

Attempts have been made by the Firemaster, Lieut.-Colonel Tylden, to

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adapt horizontal Metal Fuzes, constructed on similar principles to those of Colonel Bormann and Captain Siemens, to Shrapnel Shells of the service, having the balls fixed in sulphur, at the Royal Laboratory, at Woolwich.

One hundred and twenty have been fired, with full charges for round shot, with unsatisfactory results.

Further trials may afford the means of improving their construction, but at present they have not succeeded.

Captain Boxer's Diaphragm Shell.

With a view to the separation of the balls from the bursting powder in Shrapnel Shells, an experiment was made in 1849, with the bursting powder enclosed in canvass bags, as suggested by Captain Boxer, and the result having been favourable, he proposed in May, 1852, that the separation should be effected by means of a wrought iron plate.

This has been found to answer. 119 8-inch, and 79 24-Pr. Shells, all with 5½-inch Fuzes, having been fired with service charges for shot without a single premature explosion.

It has therefore been recommended and approved that next year's supply of the larger natures of Shrapnel Shells shall be of this pattern, and that 200 Diaphragm Shells of each of the smaller natures shall be made for trial.

The various experiments that have been made this year, and previously, with plugged shells with and without bursting powder, as well as the experiments of General Shrapnel, those with Captain Boxer's Diaphragm Shells, and with Captain Siemens' Shells, all tend to prove, that whatever other causes may exist for premature explosions, the principal one is, the ignition of the powder by the friction of the balls against each other, or against the side of the shell, and that this may be obviated by the separation of the balls and powder.

In some of the Continental Artilleries this has been effected by fixing the balls with sulphur, pitch, plaster of Paris, or other material.

The Committee have already reported that they consider Captain Boxer's Diaphragm Plate preferable, but this mode is not applicable to the shells now in the service.

There are a number of Shrapnel Shells and Fuzes in store at Woolwich, and in considering whether it is desirable to use these shells as they are, to condemn them, or to render them as efficient as possible, it is necessary to remember that in 1852, every shell that was sent to Shoeburyness was emptied, cleaned, and refilled with balls, and every fuze prepared and fitted with the greatest care by Lieut.-Colonel Robe, precautions to which may be attributed the comparatively small number of premature bursts which occurred, viz. :—37 out 656, or less than 6 per cent.

This year the shells have been fired (without these precautions) as received from store, and as they would be fired at out-stations and on service, small particles of grit or sand among the balls would no doubt increase the liability to ignition of the powder by friction, and it appears probable that great care in the preparation, and a temporary partition of moderate strength between the powder and balls, whether of flannel, clay, sulphur, or other substance, would make nearly the whole of these shells serviceable, and it

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seems advisable that steps should be taken to ascertain what means may be most advantageously used for this purpose.

Among the shells here referred to, those of Captain Boxer's pattern, supplied by contract this year, are included.

Extract from Memorandum dated 29th December, 1854, drawn up by Colonel Pickering, for the Select Committee.

With reference to memorandum dated 9th January, 1854, wherein it is stated that—

"It appears probable that great care in preparation, and a temporary partition of moderate strength between the powder and the balls, whether of flannel, clay, sulphur, or other substance, would make nearly the whole of these (the old Shrapnel) shells serviceable, and it seems desirable that steps should be taken to ascertain what means may be most advantageously used for this purpose."

Steps have been taken, and this object has been effected by a plan proposed by Captain Boxer, viz.: the introduction of a metal bouch in the fuze hole of the shell, with a tin cylinder attached to hold the bursting powder.

So efficient has this proved, that during the whole of the experimental practice at Shoeburyness this summer, in which many of these Shrapnel Shells of all natures have been fired, not a single premature burst has taken place, so that the object for which the alteration was made has been most successfully attained.

In the practice of the companies under instruction, two premature explosions occurred, but these failures may fairly be attributed to causes distinct from any fault of the principle adopted.

Of blind shells during the practice there have been several latterly, but of those it is not unreasonable to suppose that nearly all were attributable to imperfect boring or extinction of the fuze by striking on the wet sand.

The following is an extract from a letter from Colonel R. Wilson, the Officer in charge of experiments and practice at Shoeburyness, respecting shells which did not burst:—

"The 1st. (I conceive) imperfectly bored.
"2nd. Same cause.
"3rd. Fuze knocked out on striking the sand.
"4th. Shell struck the ground, and smashed the fuze.
"5th. Fuze out, evidently badly driven.
"The whole of the collars remained in uninjured.
"I think Boxer's Fuze the best I have ever seen—with care they never fail."

One fuze was blown out by the explosion of the bursting powder, without bursting the shell.

The result of the practice generally, has proved the very great advantage gained to the service by the adoption of the principle of separating the powder from the balls in the shell, and of boring a small hole in the head of the fuze composition, the one preventing premature explosion, the other securing the ignition of the fuze composition.

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The experiments during the summer, however, while they have been extremely satisfactory with regard to these two main points, shewed an irregularity as to the time of burning of the composition in the fuzes, which requires correction, and eventually led to the discovery, by Captain Boxer, that the grease, with which the instruments used for boring were touched in the manufacture of the fuzes, was communicated to the wood, and ultimately to the fuze composition, increasing its time of burning, and otherwise affecting its efficiency.

The discovery is particularly valuable, as it also accounts for the defects in Rocket Fuzes, which have, for many years, been prepared in a similar manner, and have been injured by a similar cause.

This defect in all wood fuzes has now been remedied by the disuse of grease.

With respect to the shells also which have been filled with balls separated from the bursting powder, the composition in which they were at first imbeded was found occasionally to adhere with some of the balls to the side of the shell.

Resin has been substituted, and this evil diminished, if not entirely remedied.

The Bursting Powder, being collected nearly in the middle of shell, a greater lateral spread and less longitudinal spread of the balls is thereby produced, though the area they cover is much the same.

The Carbine Balls in the smaller natures of shells have been found very efficient, as appears by a letter from Captain Brandling, dated 24th May, 1854, although latterly Colonel Wilson has complained of want of penetration, which he attributes to the solidity of the composition used for fixing the balls.

This may be rectified by the substitution of resin.

It has been proposed to harden the lead balls by mixing them with antimony.

Iron Balls have also been suggested for the larger natures of shells.

These Shrapnel Shells are now considered secure against premature explosion, even if fired with the full charges for solid shot.

In all the experiments that have been made with the future Shrapnel Shell of the service, viz.: the Diaphragm Shell, full charges have been used with perfect safety, and it is suggested that great advantage and convenience would arise from adopting generally for Shrapnel Shells, the same charges as are used for solid shot.

In Shell Guns and large natures of ordnance of cast iron, this rule will require some modification. The charge for the 32-pr. common shell has lately been reduced.

Hollow Shot for 8-inch guns weighs only 48 lbs., while the Shrapnel Shell for the same guns weighs 61 lbs.

The measures adopted for the improvement of the old Shrapnel Shell having thus been attended with great success, as evidenced by the experiments at Shoeburyness, as well as by most satisfactory reports of their efficiency in the Crimea, it is suggested that a more extensive application of these improvements may now safely be effected, and steps taken for providing outstations at home and abroad with equally good shells.

9th January, 1854. .

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Memorandum on Shrapnel Shells.

By Captain Boxer, R.A.

Certain opinions in condemnation of the *principle of construction* of the Diaphragm Shrapnel Shell having been widely circulated—which opinions have been formed upon the most imperfect data—the following observations are drawn up with a view to afford such information as may place this matter in its proper light, and to remove the false impressions which now exist in respect to the subject generally,—and I am sure that a careful consideration of recorded facts, and of the explanation which I shall afford, will show, that the Shrapnel Shell as arranged by the inventor has defects of a very serious character; and that if the principles which have guided me in constructing the Diaphragm Shell are properly carried out, every defect will be rectified, and the service with this nature of projectile will be rendered capable of a development considered hitherto impracticable.

In the early part of 1849, I first became aware of the unsatisfactory results which were obtained in the practice with Shrapnel Shells, from very frequent "premature explosions," and for the purpose of overcoming the defect, I designed a Fuze similar in the principle of its construction to that now adopted in the service for horizontal shell firing.

My views upon this subject having been brought to the notice of the Master-General of the Ordnance, were referred by him to the Ordnance Select Committee, who recommended that a series of trials should be made in order to determine the true cause of failure.

These experiments took place in the marshes at Woolwich in 1849, and the results proved beyond doubt (at least to my mind) that the failures resulted in a great measure from the bursting charge being mixed with the bullets, and that no alteration of the fuze would altogether prevent premature explosions.

The general opinion then entertained in regard to this matter was, that the shell was not sufficiently strong to withstand the "shock of the discharge," in fact that the shell was broken by the direct action of the charge in the gun.

This opinion was found to be fallacious by the following experiment, which also manifested the principal defect of General Shrapnel's arrangement.

8-inch, 32-pr., and 24-pr. Shrapnel shells carefully selected were prepared as follows, and fired with charges of 10 lbs., 10 lbs., and 8 lbs. respectively.

1. Filled with bullets and *the bursting powder*, and with a solid plug of wood firmly driven into the fuze-hole.
2. Filled with bullets, but *without the bursting powder*, and with a solid plug of wood firmly driven into the fuze-hole.

Nearly the whole of the shells with the bursting powder exploded in the gun, but there was not ONE *breakage with the shells* WITHOUT THE BURSTING

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POWDER.

The same description of shells were then fired with a reduction of 2 lbs. in the charges, with similar results.

I noticed in these trials that some of the shells *with bursting powder* which were not destroyed in the gun, burst upon striking the butt, although there was no fuze in the shell.

These results led me to the following conclusions :—

1st. That with the most perfect fuze premature explosions would occur.

2ndly. That the shell was strong enough, if properly made, to withstand the direct action of the charge; and

3rdly. That by the shock which the projectile received at the "discharge," sufficient heat was evolved in some *part* of the interior of the shell, by friction or condensation, to ignite the bursting powder.

In order to diminish the effect from friction, I suggested that the interior of the shell should be coated with a cement. Some shells so prepared were fired, but with most unsatisfactory results; in fact, if I recollect rightly, there were more failures with the coated, than with the ordinary shells.

I then proposed the principle of separating the bursting charge from the bullets, as the *only* means of *securing* success. Some shells arranged according to this principle were fired, and the results of the trial were very satisfactory.

The Select Committee did not then agree with me as to the necessity of separating the powder from the bullets, and proposed, after a very limited trial, to remedy the defect by reducing, very considerably, the charges of the guns.

This proposal I felt sure would, if carried into effect, only lead to disappointment; for besides seriously diminishing the effect of the projectiles as regards the velocity of the bullets, premature explosions would still take place, although not perhaps to the same extent as before.

If it were necessary to raise the whole of the bursting powder, or any large portion of it, to a certain temperature to cause ignition, then by limiting the charge, failures from premature explosion might be entirely prevented. But when, as is the case, the ignition of one grain, or portion of a grain, is sufficient to explode the whole charge, it is clear that no positive security against failure can result by reducing the charge in the gun when the bullets are mixed with the powder.

The recommendations of the Select Committee, as stated above, were adopted, and the charges for the 8-inch, 32-pr., and 24-pr. were fixed at 6 lbs., 6 lbs., and 5 lbs. respectively.

As the suggestion of separating the powder from the bullets was not entertained, I proposed that all Shrapnel Shells should be constructed according to the inventor's original pattern, namely, with a "lip," by which arrangement the bullets could be packed firmly in the shell, and thus cause a diminution in the action tending to ignite the bursting powder.

A number of shells so constructed were fired at Shoeburyness in 1852, and the results were satisfactory;—the same pattern however failed most completely in 1853, and altogether the practice both at Shoeburyness and elsewhere most fully confirmed my views in respect to the effect of reducing the charge of the larger nature of guns.

Similar experiments to those carried on at Woolwich in 1849, and which

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I have already noticed, were made at Shoeburyness; and so striking were the results that even the most sceptical were forced to acknowledge that to render the Shrapnel Shell an efficient projectile, a separation of the bullets from the powder was necessary.

In the trials made in 1849, the fuze-holes were secured with solid wooden plugs, and it was imagined by some that these wooden plugs had been forced out when the shells were in the gun, by the re-action of the bullets, and that the flame from the explosion of the charge was communicated to the bursting powder through the fuze-hole. This hypothesis was put to the test of experiment:—14 24-pr. Shrapnel Shells were carefully selected, the fuze-holes tapped with a screw, and the shells thoroughly cleaned. 8 were filled with bullets closely packed, and with the bursting charge, viz., 6 ozs. of powder, and the remaining 6 with bullets, but *without* the bursting powder.

The fuze-holes of the whole were perfectly secured by *screwing* in gun-metal plugs. These shells were fired at Shoeburyness on the 7th to 11th of October, 1853, from a 24-pr. Howitzer, with charges of 2½ lbs., when *six out of the eight shells which contained bursting powder* burst in the bore of the howitzer, but the 6 without the bursting powder were uninjured.

In the very extensive experimental and other practice with Shrapnel Shells of the original construction which I have had an opportunity of witnessing since 1849, I have particularly noticed the varied character of the results. At times few, if any, premature explosions occurred; at other times almost every shell that was fired burst in the gun, although the conditions appeared to be precisely the same; and I observed also that with the 24-pr. Howitzer, with the small charge of 2½ lbs., the failures were generally far more frequent than with other field guns.

Although the suggestion of separating the bursting powder from the bullets was rejected by the Select Committee in 1849, I felt sure from the experiments which I had witnessed, that sooner or later this principle would be adopted; and I only waited for a favourable opportunity to renew my proposal.

This occurred in 1852—the date I am not certain of—when some experiments were made in the marshes with Field Artillery, and the Minié rifle, in which the extremely unsatisfactory condition of Shrapnel Shells was plainly manifested; and I immediately brought the subject to the notice of the Master-General, and proposed the Diaphragm pattern.

In designing the Diaphragm Shrapnel Shell, an endeavour was made to fulfil the following conditions:—

1st. That the shell shall resist the shock from the explosion of the full service charge; and

2nd. That the bullets when relieved shall be but slightly affected in the direction of motion of the shell, by the action of the bursting powder.

In regard to the first point—as the velocity of the bullets must be considerable to render them effective—and this velocity being derived from the action of the charge of the gun—any reduction in the charge must cause a corresponding reduction in the effective range; hence the advantage of firing Shrapnel Shells with the full service charge; but whatever charge is used, there ought to be great security that no premature explosions shall occur, or this description of projectile could not be used with advantage under a

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great variety of circumstances, which must constantly occur in warfare—particularly now, when, from the great perfection in the rifle, skirmishers will be employed so much more extensively than heretofore.

With reference to the second condition, namely, that the bullets when relieved shall be but slightly affected in the direction of motion of the shell by the action of the bursting charge. From the great difficulty of correctly judging the distance of an object, the real efficiency of the Shrapnel Shell will be much affected by any great dispersion of the bullets from the action of the bursting powder; in fact it is a matter of great importance to limit the divergence of the bullets from the trajectory of the shell to such an extent, as to make it a matter of little consequence whether the shell bursts 50 or 100 yards from the object fired at.

A separation of the bullets from the bursting powder being absolutely necessary to fulfil the first condition, it became a question as to the best mode of carrying out the principle. My first idea was to arrange the shell according to the plan which I afterwards adopted to overcome the defect of premature explosions in the old Shrapnel Shells; but I soon perceived that the arrangement, although simple, would not fulfil the second condition; for in the first place, the action of the bursting powder must be sufficiently great to break the shell into comparatively small pieces in order to separate the bullets; and in the second place, the whole force from the explosion of the bursting powder acting from the centre of the mass in an outward direction, would thereby cause great dispersion in the bullets.

These considerations induced me to seek for some more efficient plan, and to adopt the arrangements carried out in the Diaphragm pattern.

The peculiar features of the Diaphragm Shrapnel Shell consist,—in the separation of the interior of the shell into two parts by a wrought iron partition or diaphragm—and in the metal of the shell being so disposed as to cause the bursting powder to open the shell in a manner to relieve the bullets, without causing irregular dispersion from the trajectory of the projectile.

The accompanying drawing, figures 1 and 2, represent sections of the Diaphragm Shrapnel Shell. Fig 1 is made by a plane which contains the axis of the fuze hole—and fig. 2 by a plane at right angles to this axis.

The bursting powder, which is contained in the chamber (*p* fig 1), being in advance of the bullets, and entirely separated from them by the wrought iron partition *(d)*, is not affected by the shock received from the explosion of the charge in any greater degree than the bursting powder of a common shell—this arrangement, therefore, entirely remedies the defect found to exist in the original construction, in reference to the ignition of the bursting charge by the action of the bullets,—and it only remains to regulate the thickness, or rather strength, of the shell to resist the direct action of the force of the charge, in order to obtain security against premature explosions.

It appears from the results of many experiments, that the thickness of metal adopted by General Shrapnel, is all that is necessary to secure the above result, even when the shells are projected with very high charge, provided the material be of a strong and tough character, and that there be an absence of flaws. This thickness of metal has therefore been taken as the basis of construction in the Diaphragm pattern.

The next point to be considered, and it is one of great importance, is that which refers to the action of the bursting powder. It is quite evident, that

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unless some provision were made to regulate the effect of the bursting powder, the principle of General Shrapnel would be, to a great extent sacrificed—in fact, the explosion of the bursting powder would separate the shell at the part (A B fig. 1) where the wrought iron partition joins the interior surface, and the bullets would either not be relieved from the shell, or would be affected more or less in their proper course, according to the relative positions of the powder and bullets at the amount of explosion, and the force of the explosion itself. A special arrangement has, however, been made, which completely meets the difficulty; it is as follows:—

1st. In order to prevent fracture where the diaphragm joins the interior surface of the shell, the resistance to fracture is made considerably greater through A B than at any other part of the shell, as shown in fig. 1; and

2ndly. Four grooves *(g, g′, g″, g‴* fig. 2), and *(g, g′,* fig. 1), are made in the interior, extending from the fuze hole to points near the bottom of the shell, forming so many lines of "least resistance," by which arrangement, in connection with that in relation to the general distribution of metal, the shell is opened in the way represented in fig. 3, (taken by the camera from a shell burst with the regular bursting charge) and the bullets are affected but in a very slight degree, in their direction of motion, or dispersion by the action of the bursting charge.

The following objections have been urged against the principle upon which the Diaphragm shell is constructed:—

1st. That the projectile being "excentric," from the relative positions of the bullets and powder, great irregularity in flight must result.

2ndly. That owing to the powder being on one side of the bullets, their velocity and proper direction of motion are considerably affected.

3rdly. That a complete separation of the powder and bullets cannot be secured.

In regard to the first point—although the projectile be "excentric," yet, as the *centres of force and grarity* are in a straight line which also represents the *direction* of the force produced by the ignition of the charge, no rotation will be generated in the projectile, and consequently no deflection will result from the peculiar arrangement of the mass.

The above objection was made to the Diaphragm Shell when it was first proposed; and in the experiments which were carried on at Shoeburyness, particular attention was directed to this point, and it appears from the reports that the flight of the projectile was very regular.

As to the second objection—the explanation already given, is sufficient to show that the principle of construction is not defective in this particular; in fact, that if the design be efficiently carried out, the peculiar arrangement in regard to the bursting powder and bullets will act beneficially in respect to the motion of the bullets when relieved from the shell;—but even if the desired object be not attained, as to the fracture of the shell, owing to imperfection in the manufacture or other causes, and the force of the bursting charge acts in an opposite direction to the motion of the projectile—it is clear, from the very small quantity of powder in the bursting charge, and from the extremely short time during which the force can act, that the velocity of the bullets will be but slightly affected—and a simple experiment will show this to be the case.

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In reference so the third objection—namely, that a complete separation of the powder and bullets cannot be secured—I have only to observe, that with a proper system no difficulty whatever is experienced in this matter, or in any other particular in relation to the manufacture of the projectile.

I am quite aware that the Diaphragm Shells in store are defective; but I must observe at the same time, that when the urgent demands for these shells were made, all was done that could be done, under the circumstances, to meet the wants of the service.

When the Diaphragm pattern was first proposed, I had no opportunity of making the necessary experiments, to determine various details in regard to the arrangement of the wrought iron partition, the depth of the grooves, &c., &c.; which, although in appearance but trifling, are nevertheless points upon which the success of the principle depends. However, as the results of the first trials at Shoeburyness in 1852 and 1853 were reported as highly satisfactory, and as there was neither time nor opportunity to prosecute the inquiries in relation to the *most efficient* arrangement—at a period when the shells were required for immediate service—the original design was adhered to.

The shells in question were supplied by contractors, the majority of whom were totally inexperienced; and owing to the peculiarity of construction, it was impossible when the shells were delivered, to test or examine them in a way to determine whether or not the design had been correctly carried out; these circumstances alone are sufficient to account for the condition of many of the shells now in store; but although I am prepared to admit that, owing to the above causes, the Diaphragm shells which have been issued for service are defective—both in design * and workmanship—I believe it will be found on trial that the effect of these shells is nevertheless very destructive.

It only remains for me to state, that during the past few months I have pursued the enquiry in regard both to the design and manufacture, with most satisfactory results; and I have every reason to believe the object for which I have so earnestly striven, will be attained—namely, to supply the service with a Shrapnel Shell possessing all the valuable properties of the original invention, without its serious defects.

E. M. BOXER, *Capt., R.A.*,
SUPERINTENDENT,
Royal Laboratories.

* By Design I mean the details and not the principle of construction.

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Brief Notes on Siege Equipment.

By Captain J. Lyons, Royal Artillery.

(*Adjt. Siege Train, Right Attack, Sebastopol.*)

Unit of Siege Train.

The unit used in the composition of a train of Siege Artillery at the commencement of the Crimean War, consisted of 15 24-prs. of 50 cwt., 10 8-inch guns of 52 cwt., and 15 mortars, 5 being 10-inch. and 10 coehorns.

Proportions of nature and resources of the Guns of the Train.

The proportions of shot and shell guns must always depend on the nature and resources of the place besieged. A preponderance of shot guns will be required where breaching batteries have to be established and generally against masonry. Against earthworks, shells on the contrary must be employed. The Siege of Sebastopol exhibits in a remarkable manner the merits of vertical fire. Vertical fire also produces a great moral effect, and renders men more unsteady than does horizontal fire. The fire of mortars is however, very inaccurate, and the shells have not the advantage of acting in two or three different places, as shells fired horizontally may do by ricochetting. Coehorns are very useful against outworks, rifle pits, &c., they are easily moved from place to place through the trenches, require few men to work them and can be used with tolerable accuracy upwards of 600 yards.

Coehorns.

24-Prs.

The 24-pr. seems to be the best gun to employ for a siege train, no doubt heavier metal is more effective, but the increased weight of the ammunition is a great disadvantage. Up to 1500 yards the 24-pr. of 50 cwt. is perhaps as accurate as any gun in the service, and it may be fired 1500 or 2000 rounds with safety. In cases where the navy can assist with their ammunition the 32-pr. 56 cwt. might be used mounted on a siege or standing carriage. These guns could be lent by the navy from the ships, and their ammunition readily supplied. They have more accuracy and give greater range than the 50 cwt. 32-pr. When there is difficulty in providing transport the 24-pr. is to be preferred. The proportions of ammunition must depend on a variety of considerations: 600 rounds of shot and 50 of grape or canister might accompany each gun.

8-Inch Guns, 52-Cwt.

The 8-inch gun is a great improvement on the 8 and 10-inch howitzers; it can be used at much longer ranges and its fire is much more accurate. In its present construction, there appears to be a minimum of metal, and its recoil and action on its carriage and platform is consequently great, nor is it safe to continue using one of these guns after it has been struck by a shot, however slightly it may be injured. At one period of the siege of

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Sebastopol the charge for some of these guns was reduced from 8 to 6 lbs.; the change necessitated very little alteration in the elevation and but slightly affected the range, and the action on the carriage and platform was greatly lessened. Boxer's fuzes are used for these guns and seem far preferable either to percussion or concussion fuzes, both of which are very uncertain in their action. A great proportion of fuzes are extinguished by grazing, a still greater, by penetrating into earth, and these latter failures seem to increase with the velocity of the shell. Hollow shot are used from these guns, but as a rule they ought to be confined to their peculiar province of shell firing. Hollow shot may be used when only limited firing is desirable and it may be unnecessary to expend shells. The fire of shells to produce its greatest effect should generally be concentrated; the shell guns should therefore be placed, as many as possible bearing on the same point, and to avoid confusion of ammunition in the magazines, together in the batteries. 500 rounds of shell, 100 of hollow shot, and 50 of grape and cannister per gun, would be a fair proportion for a train.

Fuzes.

Hollow Shot.

Fire of Shells.

10-Inch Mortar. If the bombardment of a town, arsenal, &c. is intended, the proportion of mortars must be greatly increased, and 13-inch substituted for 10-inch: in other cases 10-inch mortars will be better, as the transport required for 13-inch is so enormous. There is a very great difference however in the comparative effect, and if the train can be supplied by sea, 13-inch mortars should be substituted. 500 shells per mortar will be required. The present method of laying mortars is unsatisfactory, an improvement in this particular is much required.

Coehorns. The coehorn mortars should have 300 rounds per mortar at the least, their ammunition is easily carried, and they are constantly in use.

Platforms. The best platforms for siege batteries are solidly laid ground platforms, and if the planking be of oak, these will probably stand any firing required during a siege. The great expense and weight of oak are objections to its use, and it will probably be necessary to use whatever timber can be found on the spot. If the difficulty of traversing can be overcome, a platform consisting of stout pieces for the wheels and trail would answer for siege carriages, and be a great economy of timber. The rear of the platform should be as nearly level with the floor of the battery as is possible, especially in sunken or half sunken profiles, where the space is very limited, otherwise great difficulty is experienced in moving guns from one embrasure to another, and in taking carts, &c., through the batteries. When garrison or ship carriages are used, luff-tackles are required for running up, particularly when the platforms are much worn or become slippery through wet. Mortar platforms of the ordinary construction answer well, but require to be made stronger for 13-inch.

Magazines. The magazines used by us at the siege of Sabastopol were

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rectangular, placed generally, in the right attack, in the solid of the battery; in the left attack, in rear of it; of three magazines of the 8 gun battery, right attack, two were blown up by the enemy's shells at different times. These were placed, one immediately on the left of the battery in continuation of it, and one in rear, behind the battery. Both were blown up by shells bursting in the communications near the doors of the magazine, and the flame communicating with loose powder within. The explosion of the magazine on the left, disabled the two guns nearest it, and so injured the battery that the left gun could not be replaced. The explosion of the magazine in rear only temporarily stopped the fire of some of the guns. To this there is the set-off of the risk incurred by the numbers going to the rear for ammunition. No instance occurred at Sebastopol of a magazine being blown up by a shell falling through the roof. At least 100 rounds per gun should be contained in the magazines, and there should be additional space provided for bursters, fuzes, stores, &c., two or three cases in each magazine. If it can be done with safety, large reserve magazines should be built near the batteries, as supplying powder to the magazines while a heavy fire is being carried on, is a work of great difficulty.

Shell Rooms, &c.

Shell rooms are required for boring and fixing fuzes, fitting shells, keeping stores, &c. Gun fuzes are best bored and fixed at the gun, under the immediate superintendence of the Officer in charge, if this is done close to the merlon, very little risk is incurred. Shells for mortars should be cleaned and prepared in the shell rooms and brought up to the mortar ready for firing. All empty powder cases and barrels should be sent back to the park by the return powder wagons, as soon as possible. A bombproof for the Medical Officer in charge of the Artillery should be provided in the batteries.

Bombproof for Medical Officers.

Magazine Men.

Magazine men should be carefully selected for their intelligence and steadiness; they should be kept always to the same posts in order to have at all times a knowledge of what ammunition and stores are in their charge, and these they should regularly hand over to the men who relieve them. Printed forms might easily be prepared beforehand and issued to the magazine men at each relief, and on these they could record accurately all ammunition served out by them, and from these forms the daily report of expenditure could be readily compiled.

Sling Wagons.

Siege Guns generally travel on their own carriages, but many instances occur when the guns require to be moved without the carriage, to replace damaged ones for instance, and in these cases sling wagons are required. In heavy ground this is incomparably the best carriage we have; in difficult places, the power of men, can be advantageously applied by wheel purchase; the slinging and unslinging too are very easily and quickly performed, so that the carriages and horses need not be kept long exposed nor under fire.

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Two sling wagons were the proportion allowed for a train at the Siege of Sebastopol, it seems that the number might be increased advantageously.

Platform wagons. Platform Wagons are useful for conveying mortars, they carry guns also, but for this purpose the sling wagon is to be preferred. They carry platforms, timber, and all sorts of heavy stores well. The proportion, five, allowed to the train, seem sufficient, or might perhaps be reduced.

Flanders wagons. Flanders Wagons are in great request in a siege; they carry the shot, shell, and powder into the batteries, and are used for moving all kinds of stores. It would be found very useful to have a proportion, say $\frac{1}{3}$ of the Flanders wagons, constructed smaller and stronger than those now in use, for the purpose of carrying shot and shell; the floors of these wagons should be fitted up with battens or otherwise, so as to keep the shot steady in their places and prevent them from rolling about. Flanders wagons are in such request that there can hardly be too many with the train. The allowance at present is six, this number might be doubled.

Trench Carts and Hand Carts. Trench carts differ from hand carts only in being made stronger, they are very useful, a great proportion of the ammunition used at the siege of Sebastopol was carried from the parks to the batteries in trench carts, drawn by men with man-harness.

Man Harness. A great quantity of man-harness should be sent with the train, it is very useful, and despite all precautions, many sets are lost. Fifteen trench carts and an equal number of hand carts are allowed for a train. Thirty trench carts and no hand carts would be better; the hand carts, from their slight construction being easily injured.

Drugs. Drugs are not of much use except on very hard ground, their own great weight and low wheels unfit them for service.

Gyns. The new 18 foot Gyn is apparently of stronger construction than the 20 foot gyn used at Sebastopol. The latter was always used singly for mounting and dismounting 68-prs. of 95 cwt., and sea service mortars, 88 cwt., and it may be presumed that the new gyn can be used in the same manner. Much valuable time is lost in the batteries by the difficulty of putting the gyn together at night, the smaller parts as the shackle, bolts, and keys, are easily mislaid, and in the confusion of working parties, &c., are thrown on one side, or get covered with earth, and are often never recovered. Fastening the bolt and shackle together would help to remedy this evil. Each battery, or at least, each line of batteries should have its own gyn always in it, and kept complete. The difficulty of moving a gyn from one battery to another across ground ploughed up by shot and shell, and probably exposed to fire, is very great, there is also much loss of time. The gyn must each time be taken to pieces, packed on a trench cart, which has to be sent from the park for the purpose, and then dragged along over the open ground as the trenches

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would rarely, if ever, allow of its being drawn through them. It would seem that for the guns of the train a lighter and more convenient gyn might be used, perhaps a modification of the French gyn would answer; there should be enough gyns to allow of one in each battery or line of batteries besides those required for the parks.

Light balls are more likely to prove useful to the besieged than to a besieger, yet some may be required in cases of sorties, or of the enemy making counter approaches, they can be fired from the coehorns, which can be easily carried to any required spot. **Light balls.**

Carcasses must be used in large numbers to produce any effect, and unless the bombardment of a town is intended, are only in the way. The number of mortars in the train must be largely increased for them. Laid for long ranges, carcasses frequently burst at the muzzle. **Carcasses.**

Night firing, of shot from guns, except at near ranges, is useless, but grape or canister may be employed with good effect, and if any guns can sweep the front of the approaches, they ought to be carefully laid before dusk with this object, so as to render assistance in case of a sortie. Nailing battens on the platforms is the only method we have of directing guns for night firing, and this mode is very imperfect. Vertical fire may be used at night with effect, as it renders the enemy's working parties unsteady, at the same time accuracy is not to be expected, as experience shows that the charge for a mortar will vary with each barrel of powder. **Night Firing.**

The present mode of sighting guns requires improvement; the centre sight is very easily damaged, and often broken off altogether. The distance between the centre sight and the tangent scale is so short, that errors of laying both of lateral deviation and elevation increase rapidly as the range increases. Excellent points of sight are obtained by using a slit in the form of a cross, and a point instead of a line as in the centre sight. It would also be much better if the line of sight could be placed on one side of the gun and removed from it, as in Mr. Armstrong's method. The sights placed in this way do not appear to be more liable to injury than they are at present, and they are easily removed. **Sighting Guns.**

Field Train, its Organization.

A most important post in the Siege train is that of chief commissary. It is desirable that it be always held by an officer of sufficient rank to hold his own with the naval and staff-officers with whom he is thrown in contact. He should have a sufficient staff under his orders of officers, commissaries of the field train, and non-commissioned officers to superintend the unloading of all vessels or convoys of ammunition, and to direct and prepare the forwarding of all stores, guns, &c., to the front. His own station will be at the main depôt, and the Officers in charge of the park will report to him. **Chief Commissary.**

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The Park.

The park should be as near the trenches as it can safely be placed, in order that the night journeys may be as short as pos-

Its Situation.

sible. The whole of the day is available for bringing up stores from the depôt to the park, and a good road between these two places will probably be constructed immediately the siege is commenced, but the night work is very severe on both men and horses, and all guns, shot, and shell should be carried during the day as close to the batteries as possible.

The men of the siege train encamp close to the park, for which they furnish sentries, they are then close to their batteries, and are available when required for duty in the park.

Adjutant and Quarter-Master.

The siege train requires its Adjutant and Quarter-Master, or both of these duties may be performed by one Officer when the number of men is not great. The Adjutant should arrange the detail of reliefs for the trenches, working, and fatigue parties, &c., and will be guided in so doing by information received from the Officer in charge of the park, who will also supply him with lists of the expenditure of ammunition in the batteries, and of casualties to guns and carriages, to be embodied in the daily report to head-quarters.

Officers in charge of the Park.

Two or more Officers should be attached to the park, under the chief commissary, on them should devolve the arrangements for the care of all guns, ammunition, and stores, from the moment they leave the park for the trenches. The commissary at the park should act simply as a storekeeper, keeping accounts, and furnishing reports of all stores, &c., received and issued. To the park Officers belong all mounting of guns and active operations carried on in the park; and the magazine men, conductors of stores, and artificers should be under their control. The Officer in charge of the park should furnish to the commanding Officer daily returns of the expenditure of ammunition in the batteries, and obtain from him the men he requires for fatigues, &c. He is, of course, under the orders of the Officer commanding the batteries which his park supplies, and receives his instructions regarding arming the batteries, and changing or removing dis-

Conveying Guns into Batteries.

abled guns and carriages, and supplying ammunition. It should be the duty of the park Officers to conduct all guns into the batteries, then they may be mounted, if necessary, by the detachment in charge of the battery. The experience of Sabastopol has shown how necessary it is that the duty of taking guns into the batteries should be confided throughout the siege to the same Officers, who thus acquire a thorough knowledge of the details of the ground, by which much time is saved and confusion avoided. Before taking a gun into battery, the Officer who is to perform the duty, should in the day-time examine carefully the route he will take, and fix it by some prominent marks; then in the evening, if necessary, he should be furnished with a working party with picks and shovels to fill up any shell holes in the road, or open

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thoroughly the cuts in the trenches through which the gun has to pass. In the English Service this has hitherto been considered part of the duties of the Engineers, but at the beginning of the night relief they are overwhelmed with work and cannot attend to the matter properly; besides, those who come to the trenches at that time, from not having previously examined the ground, cannot be certain of choosing the best road, nor can they act in concert with the Officers bringing down the guns.

Conductors of Stores.

A number of active and intelligent Non-Commissioned Officers should be selected as conductors of stores, to act under the Officers in the park.

Companies to be in charge of Batteries permanently.

If it can possibly be so arranged, each Company should have a fixed charge given it at the commencement of a siege, and not be changed except to take over a more advanced battery as the siege progresses. The men by this means, would become thoroughly acquainted with the range and elevation of each of their guns, as the same men would constantly remain at the same gun, the Officers would equally benefit, and greatly increased accuracy of fire would result. The men would also have an interest in working to improve and strengthen their batteries. As the value of the fire of the batteries altogether depends on its accuracy, everything should be done to ensure this; each Officer in charge of a battery should receive instructions how he is to direct his fire, and also be limited in the number of rounds, by this means uniformity of action of all the batteries can be obtained, and the result of the fire noted.

Accuracy of Fire.

The Artillery Officers in charge of batteries in a siege should always make sure of having, 1st, their batteries well drained; 2nd, a supply of water for the men; 3rd, convenient latrines.

Construction of their Batteries by the Artillery.

In the French and other armies the batteries are constructed by the Artillery. It is greatly to be desired that this practice were followed in our own Service, and that the men who fight the guns were allowed to place and shelter them. None are so much concerned as the Artillery that the batteries are not enfiladed, that the embrasures are properly cut, that the parapets are sufficiently solid, and the platforms skilfully laid.

Reliefs.

The system of 12 hours reliefs was found at Sebastopol to answer better than that of 8 hours, as with the latter there was not a sufficiently long rest for the men, so much time was consumed in marching to and from the trenches and camp, and this will probably be the case in future sieges. The French use 24 hour reliefs. Three reliefs are absolutely necessary if firing has to be kept up continuously for any length of time. At Sebastopol having only two reliefs, these took place at noon and midnight, in order fairly to apportion the firing.

Transport for Siege Train.

A siege train should have a proportion of transport belonging to it, at least enough to perform the service between the park and the trenches. A portion of the army train might be spe-

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cially set apart for this purpose, and furnished with stronger and heavier horses than is usual. During a siege, the field batteries must expect to be called upon to aid in carrying ammunition, but if possible they should not be required to work at night. A number of frames to be fixed on the limbers of field carriages, when the boxes have been removed, to enable them to carry shot, might form part of the siege train equipment.

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ANNUAL REPORT

AND

ABSTRACT

OF

PROCEEDINGS OF A GENERAL MEETING

OF THE

Royal Artillery Institution,

HELD ON MONDAY, 10th MAY, 1858.

COLONEL WILFORD, R.A. IN THE CHAIR.

THE Committee of the Royal Artillery Institution have the honor to submit their Report for the year ending the 31st March, 1858.

They submit the Abstract of the Accounts for the past year, shewing a balance in their favour of £123 9s. 11½d., in addition to £1,200, 3 per cent. Consols Stock.

A wide field of usefulness has been opened to the Institution by the establishment of the existing Regulations with reference to Staff appointments and the Royal Staff College, and the Committee trust that the arrangements which they have made to supply the probable wants of the Regiment will meet with general approval; and although the requirements of the service have, since the last General Meeting, greatly diminished this Garrison, they can refer with great satisfaction to the numerous and well attended Classes which now meet within their walls.

The Committee earnestly hope that the benefits which the Institution offer, will long be taken advantage of, as at present. "A reputation for Science can not long be maintained without some solid foundation;" and they trust, now that their brother officers are brought into direct competition with the rest of the Army, they will maintain for the regiment that high character which has always hitherto belonged to the Royal Artillery.

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Classes.—The French, German, and Drawing Classes, continue to meet regularly. A large number of Officers have availed themselves of these Classes.

Photography.—Three Cameras have been purchased for the use of the Institution during the past year, and the Committee deeming it desirable that Officers should have an opportunity of learning, as well as practising this art, have obtained the services of Mr Spiller, who instructs, once a week, a numerous Class.

In accordance with the announcement in last year's Report, there will be found credited to the Institution under the head of "Photography," £99 13s. 0d., the sum originally expended by the Institution in building a glass room on the roof of the theatre, but Photographers have now so much increased in number, that the present accommodation is quite inadequate; and an application was in consequence made to Government, to enlarge the glass room before alluded to, and to make two rooms in the adjoining garret for the preparation, development, &c. of pictures, thus leaving the laboratory entirely to its legitimate use. This application the Government refused but have granted permission to the Committee to make these necessary alterations at the expense of the Institution, under the supervision of the Officer Commanding the Royal Engineers. The estimated cost is £130.

Mathematics and Chemistry.—Classes for the study of Mathematics, and Chemistry, the former under Mr Fenwick, F.R.A.S., the latter under Messrs. Abel and Bloxam have also been established.

Fortification.—Some Officers having expressed a wish that a Fortification Class should be formed, the usual notice was sent out by the Secretary, but as yet, a sufficient number of Officers to form a Class have not sent in their names. Should the want of instruction and aid in the study of Fortification be more extensively felt, the Committee will consider of the best means of providing a competent instructor.

Surveying, &c.—The Class for Surveying and Field Sketching was discontinued on the outbreak of the Rebellion in India, but as many Officers were desirous of joining such a Class, and as a sum of money was inserted in the Annual Estimates for its instructor, the Committee applied that an Officer of Artillery might be named for this duty, and that the Officer appointed should be capable of giving instruction in the higher departments of Surveying, including the use of portable Astronomical Instruments.

Captain Drayson has received this appointment, a considerable class has been formed, and there are now therefore three classes, the expense of which is entirely defrayed by Government, viz. French, German, and Surveying.

General Rule.—With reference to the Classes, the expenses of which are defrayed partly by the Class and partly by the Institution, the Committee, in

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order that no officer may be deterred from joining, by a fear of the expense becoming too heavy, and at the same time to protect the funds of the Institution, have passed a rule—

> "That in no case shall the expense of a single lesson exceed 2s.; and that every officer on joining a Class, shall join for a quarter (or thirteen lessons), and afterwards monthly, and shall pay for every lesson whether present or not, unless on duty, or sick, or absent on leave for more than a fortnight."

Lectures.—The lectures to the gentlemen Cadets of the Practical Class, continue to be delivered in the theatre of the Institution, and during the winter months, were attended by many Officers, permission being obtained from the Committee every half-year.

The Committee have also, with a view to popularise and make the Institution an object of interest to all, made the experiment of "conversazioni," on the same principle as the "conversazioni" of the Royal and other learned Societies of England.

It will be for the General Meeting to consider, whether these "conversazioni" shall be repeated as occasion may offer, and upon what principles the necessary expenses shall be defrayed.

Printing and Publication.—The Second Edition of the "Handbook for Field Service," the publication of which was only announced at the last General Meeting, is so nearly exhausted that the Committee have directed the preparation of a new edition, and all officers of the regiment have been invited to contribute such additions and improvements as their experience and service may have suggested to them.

The monthly lists of the Regiment continue to be published, and in this month's publication, an improvement has been introduced in the "Seniority List," which it is hoped will be found useful.

Kane's List of the Royal Regiment of Artillery, has also been ordered to be published by the Institution.

Library.—To the Library the Committee look with peculiar interest. A Sub-Committee, under the supervision of the Committee, has been appointed, whose duty it will be (while keeping it strictly supplementary to the Regimental Library) gradually to render it as complete as possible in all the departments of science and art, and especially in those capable of application to the theory and practice of Artillery.

The list of books presented and purchased is attached to this Report. Among the latter may be particularly noticed the valuable maps purchased from the heirs of the late Lieut.-Colonel Jervis, H.E.I.C.S. Continuations of Gould's "Birds of Asia," "Encyclopædia Britannica," "Palæontographical Society's Works, &c., &c."

Museum.—The arrangements existing at the last General Meeting as to the setting up of birds, &c. in the Museum, continue in force. Major L'Estrange has presented to the Institution a nucleus for a Case of the

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Game Birds of Great Britain, while Colonel Devereux and Captain Glanville have added largely to the specimens from South Africa.

The "United Service Institution" has also made considerable Donations.

Turning, &c.—An application was recently made to the Committee that more perfect arrangements might be made for the Turner's and Carpenter's shop, and a suggestion that turning and other lathes should be purchased, to which Steam Power might be applied.

Mr Anderson, superintendent of the machinery department, has very kindly made two estimates of the probable expense. This letter is now laid on the table, and it is for this meeting to determine how far Mr Anderson's scheme should be put in execution.

The following Officers retire from the Committee by rotation in accordance with Rule IV :—

Colonel Wilford.
Captain Clerk.
Major Simpson.
Captain Yonge.
Lieut. Hanwell.
Captain O. R. Stokes removed from the Garrison.

It was then RESOLVED :—

I. That the Report of the Committee be received and adopted.

II. That Lectures, followed by "Conversazioni," shall be given as often as the Committee may deem expedient.

III. That no part of the funds of the Institution be appropriated to refreshment.

IV. That the system, with reference to refreshments, adopted by the Committee at the last "Conversazione," be continued.

V. That the following Officers be appointed to serve on the Committee :—

Colonel Eardley-Wilmot.
Captain Forbes.
Major Owen.
Major Andrews.
Captain Whinyates.
Lieut. Gilmour.

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The Committee therefore stands as under:—

PATRON AND PRESIDENT.

General H.R.H. The Duke of Cambridge, K.G., &c., &c.

Ex Officio.

VICE-PRESIDENTS.

The Director-General of Artillery.
The Commandant.
The Deputy-Adjutant-General.

MEMBERS.

The Assistant-Adjutant-General.
The Secretary Ordnance Select Committee.
The Brigade-Major.

Colonel Eardley-Wilmot.
Colonel Marriott.
Colonel W. J. Smythe.
Lieut.-Colonel W. B. Gardner.
Captain and Brevet-Major H. T. FitzHugh.
Captain G. H. A. Forbes.
Captain A. Orr.
Major Owen.
Major Andrews.
Captain Whinyates.
Lieut. H. J. Alderson.
Lieut. H. D. Pitt.
Lieut. Gilmour.
Dr Warren.

Captain Noble, *Secretary and Treasurer.*

VI. That Mr Anderson's Report upon the introduction of steam, purchase of lathes, &c. be referred to the Committee.

VII. That slips of paper, &c. be placed upon the Library table to enable Officers to make notes.

VIII. That the Committee be requested to consider the advisability of getting, the birds, &c. in the Museum classified and arranged.

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GENERAL ABSTRACT OF THE INCOME AND EXPENDITURE OF THE ROYAL ARTILLERY INSTITUTION, FROM 1st APRIL 1857 TO 31st MARCH, 1858.

INCOME.		£.	s.	d.
Balance Creditor, 1st April, 1857 ...	Consols Stock	500	0	0
	Cash	182	9	1
Subscriptions		562	15	0
Consols Stock		700	0	0
Dividend on Consols		24	15	2
Printing and Publication	General Printing	70	9	8½
	Sale of "Handbook"	453	17	6
Drawing	Instruction	8	9	3
	Materials	3	17	6
Chemistry		26	11	0
Photography	Repaid by Government for building Photographical Room	99	13	0
	Sale of Chemicals, &c.	41	10	4
Turning Materials		15	13	2½
Stationery		12	0	4
Library		11	14	6
Overcharges and Repairs		0	5	6
Total		£2714	1	1

EXPENDITURE.		£.	s.	d.
Chemistry		40	4	1
Drawing	Instruction	27	6	0
	Materials	13	2	6
Lectures		4	3	5
Printing and Publication	Paper	76	16	7
	Wages	65	8	5
	Boddy for binding "Handbook" ..	79	12	1½
	Materials	21	10	1¾
	Harrild for Type	59	2	
Instruments		1	3	
Library		50	9	
Museum		28	2	0
Observatory		5	18	3
Photography		93	12	9½
Postage and Parcels		7	17	1½
Stationery		43	13	1
Transcribers		0	1	6
Turning		58	17	11
Wages		45	14	0
Incidental		25	7	0½
Surveying		0	11	6
Consols		641	17	6
Balance Creditor ...	Consols Stock	1200	0	0
	Cash	123	9	11¼
Total		£2714	1	1

A. NOBLE, Captain, R.A.,
Secretary and Treasurer, R.A.I.

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Additions to the Museum and Library since the last General Meeting.

Presented to the Library.

Two Works in the Chinese Language	*Lieut.-Colonel D'Aguilar.*
Report of the State of Hospitals in the Crimea during the War	*Colonel Aylmer.*
Papers relative to the Negotiation at Vienna	*do.*
One Vol. and one Part of Prodromus Fauna Zeylanica.	*do.*
Order Book of the Royal Artillery during the War in the Crimea	*Captain Bayly.*
Pamphlets. "The Indian Crisis."	*General Sir R. Gardiner.*
A Pamphlet on the Elastic Ballistic Pendulum ...	*Lord Panmure.*
A Book found in Sevastopol after its fall	*Colonel Aylmer.*
A Treatise upon Metals	*do.*
Do Duelling	*do.*
Pamphlets. "Question of Legislative Military Responsibility"	*General Sir R. Gardiner.*
100 Vols. of the Army List	*United Service Institution.*
Four Vols. "Comments on the Question of Military Responsibility	*General Sir R. Gardiner.*
Report on the System of Training Officers	*Colonel Smythe.*
Theory of Syzygetic Relations	*Professor Sylvester.*
Military Analysis of Indian Rebellion	*General Sir R. Gardiner.*
Specification of Patents for 1857	*Patent Seal Office.*

Books Purchased.

French Almanack.
Waxed Paper Process, by Le Gray.
Gould's Birds of Asia, 1 part.
Encyclopædia Britannica, 14th and 15th vols.
Smyth's Teneriffe.
De la Rive's Electricity, 3 vols.
Two Maps of the Crimea
Geological Map of the Crimea
Map of Turkey and Greece
Map of Bombay
Map of Europe
Travels in the Punjub
Plan of Ahmedabad
} Published by Lieut.-Colonel Jervis.
Volume of the Works of the Palæontographical Society.

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Presented to the Museum.

A Russian Tangent Scale ...	*Major-General Sir R. Dacres, K.C.B.*
A Russian Knapsack and Hand-Grenade ...	*By Lieut. Maxwell, R.H.A.*
Saw-fish's head	*Trumpet-Major Lawson.*
Lanthorn fish and some small shells	*Captain Young.*
Four Kafir Skulls	*Dr Allinson.*
Case of Butterflies from Natal. Stones and Fossils from Ascension. Stone Pipes, made by the Zulu Kaffirs. Three African Spears ...	*The Hon. Lieut.-Colonel Devereux.*
Gun Metal from Seville	*Lieut.-Colonel Maberly.*
Specimens of Lava from Etna	*Captain Goodenough.*
Copper and Silver Coins	*Captain Bayly.*
Fossils from the Crimea	*Captain Pigou.*
Sets of duplicate Fossils	*Museum of Practical Geology.*
Coins and Fossils	*Lieut. Blackwell.*
Two Heads of Spring-buck. Two Bles-buck. One Skull of Lion. Tusks of the Wild Boar. Two Ostrich's Eggs. Birds, and Quiver of Poisoned Arrows	*Captain Glanville.*
Four Birds	*Major L'Estrange.*
300 Bird Skins. Eight Cases of Stuffed Birds and Animals. Various articles of Chinese dress, &c.	*United Service Institution.*
Case of Insects, and a Bottle of Reptiles	*Mr Whiteley.*
Specimens of American Wood	*Mr Jervis.*

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Remarks on the "Report of Practice," carried on in 1858, *in the Plumstead Marshes, with* 9*-pr. Field Guns, for the purpose of ascertaining the comparative merits of the* 2½ *lbs. and* 3 *lbs. charges.* By Captain HAULTAIN, R.A.

THE following is a description of the matériel employed in the Practice:—

Guns.—The ordinary Field Service pattern, 9-pr. Brass Guns: Guns.

	Weight. cwts.	qrs.	lbs.	Length. feet.	inches.	Diameter of Bore. inches.	Length of Bore. feet.	inches.
A	13	2	26	5	11·53	4·2	5	7·82
B	13	3	6	5	11·54	4·2	5	7·7

Carriages.—The ordinary Field Service pattern made of *Teak* wood:— Carriages.

			cwts.	qrs.	lbs.
A	Carriage without wheels or side arms		8	1	0
	Wheels	cwts. qrs. lbs.			
	1.	2 1 0			
	1.	2 0 27	4	1	27
			12	2	27
B	Carriages without wheels, &c., ...		8	0	22
	Wheels				
	1.	2 1 0			
	1.	2 1 6	4	2	6
			12	3	0

Platforms.—Common-ground, made of pine wood, laid level. Platforms.
15 feet long by 9 feet broad, for the first 200 rounds; and 30 feet long by 9 feet broad, for the remainder of the practice.

		Average Length.	Average Diameter.	
Charges.	2½ lbs.	$7\frac{41}{16}$ inches.	4·1 inches.	Cartridges.
	3 lbs.	$8\frac{3}{16}$ inches.	do.	

L. G. Waltham Abbey, dated February, April, May, 1857. ... ... } Used for practice at 2°, 3°, & 128 rounds at 4°. Gunpowder.

L. G., Marked C. L. H., 1856; May and April, 1857 ... ... } Used for the rest of the practice.

Shot.—The mean service guage, viz. 4·1 inches. Shot.
Between 8 lbs. 15 oz., and 9 lbs. 1 oz.

Wooden Bottoms or Sabôts.—4 oz. 1½ drs. Sabôts.
One half by means of tin straps, and one half by gun metal rivets.

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Rivets. *Rivets for Sabôts.*—Six drams. Gun metal.

Tubes. *Tubes.*—The Service Friction.

Targets. *Targets.*—Nine feet square.

Observations in relation to the Arrangements carried out in the Practice.

Object of the Practice. 1. It appears desirable to remark here, that the object of this practice, was not to obtain the most accurate Artillery practice, as under ordinary circumstances, but to ascertain the comparative merits of different charges. Such a method has been pursued as appeared best adapted to this end, the object being, to secure, as far as possible, that these charges should be fired under precisely similar circumstances.

2. As the main object of the practice would not be at all interfered with, opportunity was taken to test the comparative effects, as regards accuracy of flight, produced by the two methods of fastening the sabôts to the shot, viz., by means of tin straps, and by means of gun metal rivets.

Order of Firing. 3. At each round from the Battery, both guns were loaded with the same description of ammunition.

The 2½ lbs. and 3 lbs. charges were used at every alternate round from the Battery.

The rivetted and strapped sabôts were used at every alternate two rounds from the Battery. The following will explain the arrangement :—

No. of Round.	Gun.	Charge.	Sabôt.	No. of Round of each charge.
1	A	2½ lbs.	Rivetted	1
2	B	2½ lbs.	Rivetted	2
3	A	3 lbs.	Rivetted	1
4	B	3 lbs.	Rivetted	2
5	A	2½ lbs.	Strapped	3
6	B	2½ lbs.	Strapped	4
7	A	3 lbs.	Strapped	3
8	B	3 lbs.	Strapped	4

and so on throughout the practice.

The same round of each charge was thus fired from the same gun, and with the same sabôt fastening.

The odd number of rounds, viz., 1, 3, 5, &c., of each charge were fired from gun A, and the even numbers, 2, 4, 6, &c., from gun B.

Targets. How Placed. 4. Two targets were erected at the different ranges, in such a manner that their centres were the same distance apart, as the guns were from one another, when in the centres of their respective platforms.

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The centres of the targets were the same height above the ground as the axes of the guns when horizontal.

The general surface of the ground was level.

5. The guns at each round were finally adjusted by the Officer directing the practice, and the second gun laid after the first had been fired. **Laying.**

6. Whatever might have been the direction or force of the wind, the guns were always laid for the centres of their respective targets. By adhering to this method with so extensive a practice, a result could be deduced more satisfactory, and more to be depended on, than if allowance for wind had to be made each round, at the judgment of the Officer laying the guns.

NOTE.—The means of measuring the force of the wind were not provided. Such might be advantageously employed at practice, so as to note the force and direction of the wind at each round, both at the Battery and the Range.

7. For the first twenty rounds, the guns were laid by line of metal. and the elevation afterwards given, but it was discovered that in elevating the guns, their direction was slightly altered. This inaccuracy was found to diminish as the guns continued to be used, and did not arise from any incorrectness in the tangent scale. After the twentieth round the guns were laid and elevated at the same time.

8. The elevation was given by tangent scale, and no deviation was ever made from what had been determined upon for the several ranges, viz. for 1,000 yds. 2°; 1,200 yds. 3°; 1,300 yds. 3½°; 1,400 yds. 4°. The latter range being the extent to which the practice was carried on. **Elevation.**

9. The 1st grazes and deflections were measured by Lieutenant Blackwell, R. A., after every round from the Battery, that is, after every two rounds fired. The distance of the 1st graze from the Battery, was measured on the line of range, from that point on the latter, where the perpendicular from the first graze met it. **First Grazes.**

10. The deflections noted at practice, were the perpendicular distances of the 1st grazes from the proper line of range. **Deflections.**

11. The recoil greatly increased during wet weather, at such times coarse sand was spread on the platforms. **Recoil.**

12. It was proposed to observe the time of flight, but the necessary instrument was not available for use until the last 200 rounds, when the time of flight was observed from the Battery. **Time of Flight.**

13. The guns were examined after every hundred rounds fired from them, (in the Proof Department, Royal Arsenal), and the result has been kindly furnished by Colonel Wilmot, R. A., Superintendent Royal Gun Factories. *Vide* Table Z. **Examination of Guns.**

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Explanations relating to the "Report of the Practice," and the tables deduced from it.

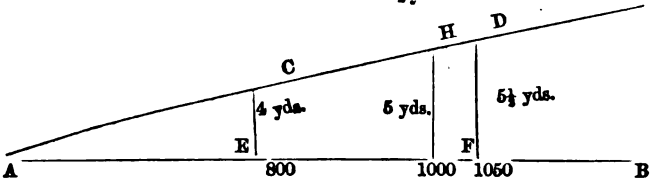
Report of the Practice.

14. The "Report of the Practice," simply contains what was noted during the practice, with the exception of the columns headed: "Deflections deducting allowance for Wind," and "Allowance for Wind." The following explanation will shew how these were obtained.

Column of Deflections.

15. In order to judge of the *comparative* correctness as regards "*direction*," of any number of projectiles, it is necessary to ascertain the deviation of their lines of flight at some one distance from the Battery.

Suppose AE= 800 yards.
and AF=1050 yards,
then if CE= 4 yards,
DF= 5½ yards.



A is the Battery.
AB the line of range.

Suppose two shots to proceed in the same direction *AD*, but one ranges only 800 yards to *C*, while the other ranges 1050 yards to *D*. The deflection of *C* is noted as 4 yards, that of *D* as 5½ yards.

It is quite obvious that the direction of these two shots, cannot be correctly judged of by comparing the deflections thus noted. But if the deviation of each at 1000 yards range is calculated, it is ascertained to be in both cases five yards, and from this result a correct opinion can be at once formed.

This plan has been followed throughout the practice, and the deflection calculated of each shot, when at the distance of the target at which it was fired, which at the several elevations was respectively, 1,000, 1,200, 1,300, and 1,400 yards.

Allowance for Wind.

16. No allowance having been made, in laying the guns, for the force or direction of the wind, much of the deflections noted at practice is due to it, as will be readily seen from the "Report." Under these circumstances, were there no other disturbing causes, the mean deflection of a day's practice would have determined what was due to the action of the wind, and as the other causes of lateral deviation, viz.: eccentricity of shot and windage, act indifferently to the right and left, it may be assumed in as

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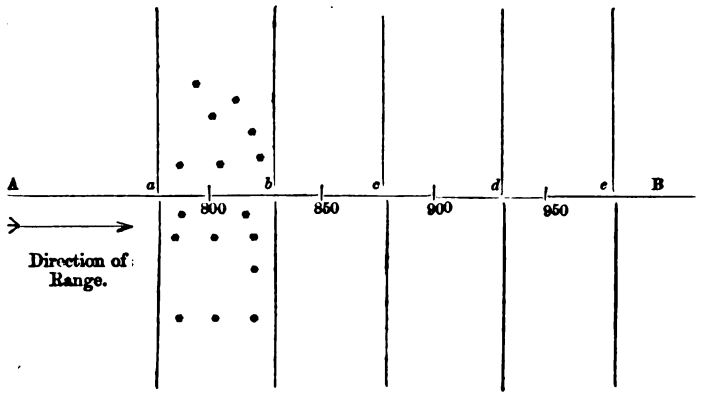
extensive a practice as this, that the amount of disturbance caused by the wind, would be fairly eliminated, by allowing for it each day's mean deflection. This has accordingly been done, separately for each charge, and is called in the "Report," "Allowance for wind."

17. This "allowance," or mean, has been deducted (algebraically, right and left having opposite signs) from each of the calculated deflections from which such mean was taken, and the result inserted in the column of the "Report" headed "Deflections at——yards, deducting allowance for Wind." For example—

At 2° elevation the deflection of each shot at 1,000 yards range, was ascertained. Of each day's practice, the mean of these calculated deflections was taken, and deducted from them; and from these results, as inserted in the "Report," the general "mean" deflection at 2° elevation was calculated.

At 3° elevation, the deviation at 1200 yards range was ascertained, and so on, according to the elevation, and the corresponding distance of the target aimed at.

18. *Tables A.*—These tables are intended to shew the comparative "extent" and "regularity" as regards *range*, obtained by the two charges, irrespective of deflection. They are arranged on the following plan:—*A* is the Battery, *AB* the line of range, *ab, bc, cd, de*, each=50 yds. The numbers 800, 850, 900, &c., denote the distance in yards from the Battery *A*, and are the centres of the spaces *ab, bc, cd, de*. Tables *A*.



The several columns of the Tables *A*, each represent one of these spaces of 50 yards, and are respectively headed by the numbers that denote their distance from the Battery. In these columns are inserted in numerical order, the 1st grazes of all shot that fell within the 50 yards designated, without reference to their deflection.

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From these tables may at once be seen the extent over which the shot ranged at the several elevations, and from the number of shot that fell within the several spaces of 50 yards, the comparative regularity, as regards range, may be judged of.

19. The "mean" ranges given in these tables, are taken from the whole number of rounds at the several elevations. That this does not give the *probable* range, the information required in a practical point of view, is made evident from the number of shot falling over and short of the mean being so disproportionate.

Table *B*. 20. *Table B.*—This table is arranged on the same plan as tables *A*, of which it is an abstract, giving the number of shot that fell within the several spaces of fifty yards, at the different elevations. It shews the general extent of the irregularity and anomalies in range. For instance, one shot fired at 2° of elevation, is seen to range farther than one fired at 4°.

Tables *M* and *N*. 21. *Tables M and Table N.*—These tables are arranged on the same plan as Tables *A* and Table *B*. Giving the same information as regards the "sabôts," that the latter tables give concerning the "charges."

Table *C*. 22. *Table C* is deduced from the column in the "Report" headed, "Deflections, deducting allowance for Wind." The numbers at the head of the table show the extent of deviation left and right. The figures in the columns show the number of shot that fell within the several distances denoted by the numbers above alluded to.

Table *O*. 23. *Table O* corresponds with Table *C*. The latter relating to "charges," the former to "sabôts."

Table *E*. 24. *Table E* shows the *extent* of the irregularity in range and lateral deviation, that occurred at the several elevations.

The "greatest deflections" given in the table, are those which have been reduced to the several distances, 1,000, 1,200, 1,300, and 1,400 yards, respectively, as explained in paragraph fifteen; but allowance for wind has not been deducted, and therefore the comparison has regard to the extent of disturbance arising from all causes.

Table *R*. 25. *Table R* gives the same information regarding "sabôts" that Table *E* gives of the "charges."

Table *F*. 26. *Table F* may be considered an abstract of the whole practice, as regards the results of the two charges under trial.

Table *S*. 27. *Table S* is the same for the "sabôts" that Table *F* is for the "charges."

Mean Deflections. 28. The mean deflections as given in Tables *F* and *R*, are taken from those calculated as in paragraphs fifteen and sixteen,

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and which are inserted in the column of the "Report" headed, "Deflections, deducting allowance for Wind."

29. *Mean Range.*—It is evident that the extent of range sometimes observed, was due, not so much to the effect of the charges fired at certain elevations, as to the amount of disturbance possible under those circumstances. In order therefore to ascertain the mean, or more correctly, the probable range, it was necessary to reject what was the result only and obviously of disturbing causes. Among other plans more elaborate that might have been adopted, one was pursued which readily admits of being modified, and may reasonably be expected to give a fair comparison, as well as a result practically useful. It is as follows :— Mean Range.

30. An extent of range to be taken, and all shot falling out of it, whether short or over, to be rejected. As the irregularity increases, or nearly so, with the elevation, a corresponding increase of range to be allowed. The following were fixed upon— How Obtained for Table *F*.

300	yds.	for 2°	of elevation.
350	„	3°	„
400	„	3½°	„
400	„	4°,	

and those spaces to be selected, within which the greatest number of shot fell, which was ascertained from Tables *A* for the "charges," and Tables *M* for the "sabôts."

31. CHARGES. *General Remarks.*—The several tables have been compiled and arranged at considerable cost of time and labor, but it is hoped that these have not been uselessly expended. The object has been to present in a tabular form, all the most important information to be deduced from the practice, in order that a conclusion may readily be drawn, as to the comparative merits of the matters under trial. CHARGES. Remarks.

32. Some of the irregularities observed are so extraordinary as to give ground for the supposition of their having been the result of more than the ordinary causes of disturbance, or of error in observation. Every precaution was taken to prevent the former, and the Officer at the range was equally careful to avoid the latter. But it is still possible that with every desire to avoid error, such might have occurred.

33. Errors in "range" were more likely to be made than in deflection, as in addition to what both are equally liable to, the moving of the gun after having been laid, an error in the former might also arise from a second graze being mistaken for the first.

34. Comparatively the largest irregularity noted was in "deflection." It was at the eighty-fourth round fired with 8 lbs., at 3½° of elevation. It was 129 yards to the right, with a range of 1765 yards, which was more by 100 yards than the Greatest Deflection.

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CHARGES. next longest range with that charge and elevation. This deflection was more than double any other noted with the 3 lbs. charge. It was not rejected in forming the tables as it would not affect any practical result that might be obtained.

Irregularity at 3½° Elevation. 35. The practice at 3½° of elevation was the most irregular of the whole. It was the last carried on with the round shot, and as there was no other apparent cause for increased irregularity, it may be attributed in part to the slight indentations produced in the bore of the gun by the previous firing.

Greatest Irregularity in Range. 36. The greatest irregularity in range also occurred at this elevation (3½°), when a shot fired with 2½ lbs. reached at its first graze, the distance of 1904 yards. This exceeded by 841 yards, nearly half a mile, the range obtained by another shot fired with the same charge and elevation.

Practice at 2°. 37. At 2° the practice was much more regular. With the 3 lbs. charge, 64 shot out of the 100 fired, fell within a longitudinal space of 100 yards; whilst 56 out of the same number, fired with the 2½ lbs., fell within the same space, and all of these, with a right direction, would probably have struck a cavalry soldier mounted, the ground being level.

Superiority of 3 lbs. Charge. *General Conclusions.*—In addition to a superiority in "*extent*" of range, invariably obtained by the 3 lbs. charge, there is a sufficient average superiority in regard to "*regularity*" of range, and also of "direction," on the part of the same charge, to make it appear, as far as this practice can establish it, that shot fired with that charge are not to the same extent affected by the causes of irregularity in practice, as are those fired with the 2½ lbs. charge. The comparison between the two charges will best be made by considering, in order, their effects as regards Extent of Range, Regularity of Range, Direction; Recoil, and Time of Flight. Effect upon the bore of the gun will also be alluded to.

Comparison.

Extent of Range. *Extent of Range.*—3 lbs. charge invariably superior, as seen by Table *F*.

Regularity of Range. *Regularity of Range.*—3 lbs. superior as seen by the following tables:—

Table *B*. The greatest number of shot that fell in any one space of fifty yards, was in favor of the 3 lbs., at every elevation.

Table *E*. In taking the mean ranges, more than double the number of shot had to be rejected, of those fired with the 2½ lbs., than of those with the 3 lbs.; also the difference between the greatest and least ranges, at the several elevations, was always less with the 3 lbs.

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A further examination of the tables alluded to, will more than confirm what has been briefly stated to shew the superiority of the 3 lbs., as regards "regularity" of range. CHARGES.

Direction.—3 lbs. superior, as seen by the following tables:— Direction.

Table *E.* In the column of "greatest deflections," it is seen that six times out of eight, there was less deviation with the 3 lbs. than with the 2½ lbs.

Table *F.* Out of eight averages taken, right and left, six of them are in favor of the 3 lbs., five of which are decidedly so, whereas the two in favor of the 2½ lbs. have no material superiority.

Recoil.—From the column of "Mean Recoil" in Table *F*, it will be seen that the additional ½ lb. to the charge, causes one-fourth more recoil, and therefore in this respect there is a decided advantage in favor of the 2½ lbs. charge. Recoil. Superiority of 2½ lbs.

Time of Flight.—It is to be regretted that the instrument for taking the "time of flight" was not available during the whole practice. Time of Flight.

By reducing the average given in Table *F*, the range corresponding to 4½ seconds of time, would be nearly

2½ lbs. 1255 yards.
3 lbs. 1290 yards.

Effect on Bore.—The two charges were fired alternately from both guns; and the examinations made during this practice, after each hundred rounds, are of no assistance in determining the comparative effects of the two charges on the bore of the gun. Vide Table *Z.* Effect on Bore.

Rapidity of fire, and the same charge always from the same gun, would be best fitted to obtain this information, arrangements quite the reverse of those carried out in this practice.

SABOTS. *General Remarks.*—After each 200 rounds the ground was well searched, in order to recover as many as possible of the shot fired, as it was desirable to ascertain whether the mode of fastening the sabôt by means of the rivet, prevented the shot freeing itself from the former, also whether the rivet remained attached to the shot after the sabôt had been separated from it. The following shot were recovered: SABOTS.

Elevation fired at.	Strapped	Rivetted. without Rivets.	Rivetted. with rivets.	Total
2°	64	40	34	138
3°	77	8	58	143
3½°	64	10	73	147
4°	68	6	62	136
Total,	273	64	227	564

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SABÔTS. Rivets Detached.

As regards the rivetted shot found without rivets, no circumstances were observed from which to ascertain when, or from what cause, the latter were detached from the shot. The larger number happening with the small elevation, might point to the graze of the shot as the cause.

Shot freed from Sabôt.

With respect to the shot freeing itself from the sabôt; out of the 291 recovered, only one was found with any part of the sabôt remaining attached to it, and this evidently arose from its having been made of a very tough knotty piece of wood, and which ought to have been rejected. It occurred at the thirty-seventh round, fired with the 3 lbs. charge, at 3° of elevation. In this instance neither range nor direction were different from the average.

Conclusions.

General Conclusions. Sabôts.—At the outset of this practice, the trial of the two modes of fastening wooden bottoms to the shot, appeared, comparatively, a matter of secondary consideration, and was altogether subordinate to the object first proposed, viz., the trial of the two charges; yet, from the results obtained, and from other considerations, its importance will be apparent.

Tables *R* and *S* should be specially referred to, as from them principally the following conclusions are drawn, in regard to Extent of Range, Regularity of Range, and Direction, the points on which depend the merits of Artillery practice.

Whilst the averages of "*extent*" of range, are as often in favor of one as of the other, in "*regularity*" of range, the superiority is decidedly on the side of the "Rivet." But it is principally in "*direction*" that its superiority is most strikingly and invariably maintained.

Extent of Range.

Extent of Range.—As often in favor of one as of the other, as seen by Table *S.*

Regularity of Range.

Regularity of Range.—Rivet superior, as shewn by the following tables:—

Table *N.* Rivet, seven times out of eight, has the greatest number of shot in any one space of fifty yards, and equal in the eighth.

Table *R.* Rivet has a less difference, six times out of eight, between the greatest and least ranges at the several elevations.

Table *R.* Rivet has only eighteen shot rejected in taking the mean ranges, while Strap has thirty.

Direction.

Direction.—Rivet superior, as shewn by

Table *S.* In the sixteen averages of deflection, right and left, inserted in this table, the superiority of the rivet is *invariably* maintained, and sometimes to a considerable extent.

Table *R.* In the column of "Greatest Deflections," the Rivet, thirteen times out of sixteen, has less than the Strap.

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Time of Flight.—Rivet superior, shewn by *note* in Table *S*. In the only two averages taken, the Time of Flight is less with the Rivetted Sabôt, than with the Strapped, and although it is considerably so in one instance, yet the trial was too limited, as regards the time of flight, to establish any thing decisive. SABÔTS. Time of Flight.

As far as this practice is capable of furnishing a decided result, the superiority of the Rivetted over the Strapped Sabôt, has been fully established to an extent little anticipated probably by any one, and not easily to be accounted for. Without this superiority, and even with a supposed slight inferiority, the advantages of the "Rivet" over the "Strap," as a means of securing the Sabôt to the shot, were deemed sufficient, and justly so, for its adoption into the service.

But there is yet an advantage, which, if not entirely overlooked, has hitherto never been made available in general practice, for controlling, and thus in a measure reducing, one of the chief causes of the irregularities and anomalies that seem inseparable from the use of spherical projectiles, viz., the eccentricity of the shot. Additional advantages of "Rivet."

Although these remarks are not immediately connected with the results of the practice, yet being connected with the subject under consideration, viz., the merits of the Rivet, and the tenor of them being thought of some importance to the service, advantage has been taken of so favorable an opportunity to bring forward, with all deference, a few practical suggestions, as to its more general use.

Before adverting to the use of the means now available for controlling the cause of disturbance alluded to, it will be advisable, in order to give weight to, as well as a reason for, these remarks, to give the opinions entertained by men, who, from their acknowledged ability, as well as from their attention to the subject, and practical acquaintance with it, are entitled to the consideration and confidence of others less favored than themselves.

Sir Howard Douglas, in his work on "Naval Gunnery," alluding to some experimental practice that had been carried on with eccentric projectiles, states—

Page 201,

"The result of these very curious and instructive experiments "fully explain the extraordinary anomalies, as they have hereto- "fore been considered, in the length of range and in the lateral "deviations. These have been attributed to changes in the "state of the air, or the direction of the wind, to differences in "the strength of gunpowder, and to irregularities in the degrees "of windage. All these causes are, no doubt, productive of Accidental position of centre of gravity of shot, one great cause of irregularity in practice.

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"errors in practice, but it is now clear that those errors are "chiefly occasioned by the eccentricity and non-homageneity of "the shot, and the accidental positions of the centre of gravity "of the projectiles, with respect to the axis of the bore."

Commander Dahlgren, in charge of the United States Experimental Ordnance Department, Washington, in his work on "Shells and Shell Guns," expresses his opinion no less decidedly on the subject—

Page 90.—"Irregularities occur in the best practice, which "are not accounted for by variation in elevation, or direction, or "force of projection, and must be due to some other cause. "*That*, all experiment indicates to be the oblique action of the "resisting medium, produced by variable eccentricity."

Page 90.—"The ill effects (of eccentricity) are neutralized "to some extent by controlling the position uniformly."

Page 87.—"When the centre of gravity lies in the axis of "the bore, its effect is trifling, and the trajectory nearly corre-"sponds with that of the concentric projectile."

If the opinions above expressed are correct, then by the introduction of the "Rivet," a simple and inexpensive means has become available for controlling the chief cause of irregularity in Artillery practice.

How to fix Centre of Gravity.

As no care in the fabrication of shot will ensure perfect concentricity, the next object to be attained is, to be able to fix the position of the centre of gravity of the shot in the axis of the gun, *without loss of time in serving it.* This can be secured as follows:—

If a shot be floated in mercury, and allowed to come to rest, the axis passing through the vertex or culminating point, will contain both the centre of gravity, and centre of form of the shot. Let this vertex be marked, and the point corresponding to it on the opposite side of the shot be ascertained, then by fastening the rivet to the latter point, those conditions are secured, which are supposed by Commander Dahlgren almost to neutralize the ill effects of eccentricity, as is stated in the last quotation given.

By this simple method of securing the sabôt, viz., determining the position of the Rivet, instead of fixing it accidentally, the relative positions of the centres of gravity and form of the projectiles must remain the same, and therefore no more care or time required in loading than are at present necessary.

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Should these conditions produce the increased regularity in practice, which Commander Dahlgren supposes they are capable of doing, there appears to exist no sufficient reason why the sabôtted shot should be confined to field guns. The simple manner in which the Rivet can be made use of, points it out as peculiarly applicable to shot of large calibre, for all shot having been once prepared for the rivet, before being issued for service, can be transported independently of the sabôt as at present. They can be used with or without the latter as thought advisable, and the sabôt can be attached at any time or place, as no mechanical skill, nor any appliances beyond a common hammer, are required in fixing with the rivet, a sabôt to a shot. Extended use of Rivetted Sabôt.

The proportions and material both of the sabôt and the rivet, can be easily modified as required.

The manifest existence of very great irregularities in practice, seem to point out, Practical suggestions.

Firstly. That every cause of error should be reduced within its narrowest possible limits.

Secondly. The necessity of extensive experiments to arrive at conclusions to be depended on.

Thirdly. The desirableness of tables of range, &c., deduced from such experiments.

Fourthly. In order to make reports of ordinary practice as valuable as they might be, the greatest pains should be taken to ascertain correctly, the distance of the object fired at, and to note precisely any alteration in the elevation of any particular round.

Fifthly. The importance of having Artillery Officers and Men much practised in judging distances under all circumstances.

It is hoped that these remarks will not be considered out of place. The subject has been necessarily much before the writer's mind for some months past.

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TABLES A.

GUNS, NINE-POUNDER, BRASS.

Comparison of 1st Grazes of Shot fired with Charges 2½ lbs. and 3 lbs.

Elevation 2 degrees.

The numbers in the Columns denote the 1st grazes in yds. Each Column represents fifty yards in range. The numbers at the head of the Columns denote the distance from the Battery.

800		850		900		950		1000		1050		1100		1150		1200	
2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.
yards.	yards.	yards.	yards.	yards.	yards.	yards.	yards.	yards	yards.	yards.	yards.	yards.	yards.	yards.	yards.	yards.	yards.
798		825	826	876	877	927	926	976	975	1029	1025	1082	1076	1132	1130	1177	—
798		837	839	880	882	930	927	983	978	1030	1026	1083	1077	1139	1147		
811	816	843	863	880	883	930	927	1002	979	1042	1026	1089	1080				
818	820	844	868	881	895	931	928	1010	979	1040	1029	1123	1082				
819		845	873	883	897	931	933	1015	980	1050	1030		1109				
821		850		884	900	932	933	1016	981	1053	1032		1112				
822		850		885	904	932	933	1017	987	1050	1033						
		850		885	908	934	935	1018	990	1066	1043						
		853		889	908	935	936	1022	990		1072						
		857		891	910	943	938	1024	991		1073						
		867		893	910	944	943		991								
		868		897	911	947	947		991								
		869		897	915	947	947		991								
				898	919	950	950		992								
				899		950	950		994								
				900		950	951		999								
				901		952	951		1001								
				904		954	952		1001								
				905		962	955		1002								
				906		963	960		1002								
				907		964	960		1003								
				908		967	964		1003								
				912		973	964		1006								
				913		974	967		1007								
				915			968		1009								
				916			972		1010								
				916					1011								
				916					1012								
				920					1012								
				920					1016								
				921					1018								
									1019								
									1021								
									1022								
									1023								

First Grazes.	2½ lbs.	3 lbs.
	yds. ft. in.	yds. ft. in.
Maximum range ...	1177 0 9	1147 2 3
Minimum do. ...	798 1 0	816 1 6
Difference	378 2 9	331 0 9
*Mean range	936 2 2	973 2 0
No. of shot beyond mean.....	40	53
No. of shot short of mean	60	47
Two centre shots as taken in numerical order...	920 1 4 921 1 0	979 2 0 979 2 6

	800	850	900	950	1000	1050	1100	1150	1200
2½ lbs. ...	7	13	31	24	10	8	4	2	1
3 lbs. ...	2	5	14	26	35	10	6	2	0

* These means are taken from all the rounds, and consequently are not the same as those taken for Table F.

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Elevation 3 degrees.

950		1000		1050		1100		1150		1200		1250		1300		1350		1400		1450	
2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.
931	—	980	1000	1030	1033	1077	1078	1125	1125	1179	1176	1229	1229	1294	1275	1326	1327	1379	1411	1436	1431
966		1003	1001	1034	1048	1078	1081	1127	1135	1118	1179	1233	1230	1310	1278	1335	1345	1389			1471
		1005	1002	1036	1050	1082	1086	1130	1135	1193	1188	1243	1230	1315		1354	1345	1404			
		1010		1039	1055	1084	1097	1134	1138	1198	1188		1231	1323			1345				
		1011		1045	1107	1085	1097	1136	1140	1203	1191		1233								
		1013		1045	1107	1086	1101	1136	1141	1205	1191		1233								
		1016		1046	1108	1088	1105	1138	1142	1211	1192		1237								
		1019		1051		1091	1107	1141	1142	1213	1194		1238								
		1021		1056		1091	1108	1141	1142	1213	1194		1245								
				1061		1094	1108	1143	1142		1195		1246								
				1063		1099	1118	1144	1145		1195		1252								
				1063		1100	1122	1146	1144		1196		1253								
				1064		1101	1124	1146	1146		1197		1253								
				1066		1104		1151	1146		1202		1258								
				1067		1107		1155	1148		1205		1260								
				1068		1108		1161	1150		1206		1263								
				1071		1109		1161	1150		1209		1263								
				1073		1113		1162	1151		1212		1267								
						1112		1164	1153		1215		1269								
						1116		1164	1155		1215										
						1122		1165	1156		1217										
						1123		1172	1156		1218										
						1123		1173	1157												
						1124		1173	1163												
									1163												
									1163												
									1171												
									1171												
									1174												

First Grazes.	2½ lbs.			3 lbs.		
	yds.	ft.	in.	yds.	ft.	in.
Maximum range	1436	1	0	1471	1	6
Minimum do.	931	2	0	1000	0	6
Difference	504	2	0	471	1	9
*Mean range	1133	2	0	1183	0	9
No. of shot beyond mean	44			47		
——— short of mean	56			53		
Two centre shots as taken in numerical order ...	1122	0	0	1174	0	0
	1123	2	0	1176	2	6

	950	1000	1050	1100	1150	1200	1250	1300	1350	1400	1450
2½ lbs.....	2	9	18	24	24	9	3	4	3	3	1
3 lbs.....	0	3	4	14	29	22	19	2	4	1	2

* These means are taken from all the rounds, and consequently are not the same as those taken for Table F.

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TABLES A.—*Continued.* Elevation 3½ degrees.

1050		1100		1150		1200		1250		1300		1350		1400		1450		1500		1550		1600		1650		1700		1750		1800		1850		1900	
2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.
1063	—	1075	1088	1125	1154	1178	1192	1255	1229	1275	1284	1325	1325	1378	1375	1431	1430	1488	1491	1541	1525	1577	—	1632	1638	—	—	—	1765	—	—	—	—	1904	—
1069		1100		1143	1171	1188	1192	1228	1236	1279	1298	1325	1328	1377	1375	1434	1434		1500	1547	1536	1608			1670										
		1110		1152		1192	1199	1228	1239	1279	1299	1330	1329	1380	1379	1438	1443		1507	1548	1540														
		1119		1152		1192	1215	1232	1244	1283	1302	1331	1331	1382	1379	1442	1445		1508	1567	1573														
				1152		1198	1219	1240	1244	1287	1304	1337	1337	1389	1380	1469	1456		1513	1570															
				1155		1198	1224	1242	1245	1289	1307	1338	1340	1389	1383	1470	1465		1517																
				1173		1200		1242	1245	1289	1311	1341	1346	1391	1393		1469		1524																
						1203		1243	1247	1297	1312	1346	1347	1395	1399		1473																		
						1206		1247	1252	1300	1317	1362	1347	1395	1403																				
						1209		1257	1253	1302	1319	1371	1350	1400	1406																				
						1211		1257	1353	1306	1320	1371	1352	1401	1407																				
						1212		1259	1258	1310	1320		1353	1405	1423																				
						1212		1261	1260	1311	1323		1353	1408	1423																				
						1216		1262	1262	1315	1323		1359	1423	1423																				
						1220		1265	1264				1360																						
								1269	1264				1360																						
								1273	1264				1361																						
									1267				1362																						
									1272				1362																						
													1363																						
													1365																						
													1369																						

	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900
2½ lbs	2	4	7	15	17	14	11	14	6	1	5	2	1	0	0	0	0	1
3 lbs.	—	1	2		19	14	22	14	8	7	4	0	2	0	1	0	0	0

First Grazes.	2½ lbs.	3 lbs.
	yds. ft. in.	yds. ft. in.
Maximum range	1904 0 0	1765 0 0
Minimum do.	1063 0 0	1088 1 6
Difference	841 0 0	676 1 6
*Mean range	1315 1 10	1354 2 6
No. of shot beyond mean	41	45
——— short of mean	59	55
Two centre shots as taken	1287 0 0	1347 2 0
in numerical order ...	1289 0 0	1347 0 0

* These means are taken from all the rounds, and consequently are not the same as those taken for Table F.

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Elevation 4 degrees.

1150		1200		1250		1300		1350		1400		1450		1500		1550		1600		1650		1700		1750		1800		1850		1900	
2½ lbs.	3 lbs.	2½ lbs	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.	2½ lbs.	3 lbs.
1129	1146	1180	1199	1246	1250	1279	1291	1325	1329	1375	1377	1427	1425	1476	1480	1552	1525	1581	1590	1631	1641	1700	1678	1730	—	1777	1802	—	—	1900	—
		1181		1247	1262	1287	1298	1329	1332	1375	1378	1432	1428	1481	1482		1531	1593	1597	1632	1642		1716								
		1182		1247	1265	1289	1299	1330	1333	1379	1380	1446	1436	1484	1484		1533	1600	1600	1647	1644										
		1188		1250	1265	1293	1301	1334	1337	1380	1384	1449	1437	1485	1496		1540		1604	1673	1661										
		1206		1254	1272	1300	1302	1339	1340	1383	1387	1451	1441	1502	1501		1548		1604												
		1220		1254	1274	1300	1307	1340	1345	1383	1387	1454	1442	1510	1508		1558		1607												
		1225		1255		1303	1309	1342	1346	1385	1393	1458	1446	1519	1508				1609												
				1261		1304	1310	1344	1371	1385	1395	1469	1448		1511				1612												
				1261		1305	1315	1348	1372	1393	1397	1470	1459		1511																
				1269		1306	1315	1353		1398	1399	1472	1459		1512																
				1269		1308	1317	1353		1400	1399		1459		1513																
						1311	1321	1358		1400	1400		1460		1520																
						1312		1361		1401	1401		1461		1524																
						1314		1363		1403	1402		1465																		
						1318		1372		1403	1403		1469																		
						1318		1376		1411	1404		1471																		
						1321				1418	1417		1472																		
						1323				1418	1418		1472																		
											1420																				

	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900
2½ lbs...	1	7	11	18	16	18	10	7	1	3	4	1	1	1	0	1
3 lbs....	1	1	6	12	9	19	18	13	6	8	4	2	0	1	0	0

	2½ lbs.	3 lbs.
	yds. ft. in.	yds. ft. in.
Maximum range ...	1900 0 0	1802 1 4
Minimum do. ...	1129 2 0	1146 1 4
Difference	770 1 0	656 0 0
*Mean range	1385 0 3	1437 1 10
No. of shot beyond mean	41	52
No. of shot short of mean	59	48
Two centre shots as taken in numerical order ...	1361 2 0 1363 2 8	1428 1 5 1436 2 0

* These means are taken from all the rounds, and consequently are not the same as those taken for Table F.

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TABLE B.

Guns, 9-Pr. Brass. FIRST GRAZES. Charges, 2½ lbs. and 3 lbs.

Each Column represents a space of 50 yds. of range. The number at the head of each Column is the distance in yards from the Battery, and is the centre of the space represented by that Column. The number in the Columns shew the number of shot that fell within each 50 yds.

Target.	Elevation.	Charge.	800	850	900	950	1000	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900
yards.	degrees.	lbs.																							
1000	2°	2½	7	13	31	24	10	8	4	2	1														
		3	2	5	14	26	35	10	6	2	—														
1200	3°	2½	—	—	—	2	9	18	24	24	9	3	4	3	3	1									
		3	—	—	—	—	3	4	14	29	22	19	2	4	1	2									
1300	3½°	2½	—	—	—	—	—	2	4	7	15	17	14	11	14	6	1	5	2	1	—	—	—	—	1
		3	—	—	—	—	—	—	1	2	6	19	14	22	14	8	7	4	—	2	—	1	—	—	—
1400	4°	2½	—	—	—	—	—	—	—	1	7	11	18	16	18	10	7	1	3	4	1	1	1	0	1
		3	—	—	—	—	—	—	—	1	1	6	12	9	19	18	13	6	8	4	2	—	1	—	—

One shot fired with 2½ lbs., at 2° Elevation, ranged 48 yards further than one fired at 4° Elevation, as under,

	2°	4°
2½ lbs.	1177	1129
3 lbs.	1148	1146

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TABLE C.

DEFLECTIONS.

Guns, 9-Pr. Brass. Charges, 2½ lbs. and 3 lbs.

The numbers at the head of the Table denote, in yards, the extent of deflections left and right.
The figures in the Columns shew the number of shot that fell within the several distances, denoted at the head of the Table.

Target.	Elevation.	Charge.	Left.													⊙	Right.																		
			60	55	50	45	40	35	30	25	20	15	10	5	2		2	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
		lbs.																																	
1000	2°	2½											4	14	14	33	16	14	3	2															
		3											—	10	25	34	17	13	1	—															
1200	3°	2½											9	14	20	22	15	13	4	1	1	1													
		3										4	6	12	14	25	17	16	3	2	1	—													
1300	3½	2½				2	—	—	—	1	6	4	13	11	8	17	9	10	5	4	2	1	2	1	—	1	1	1							
		3			1	—	—	—	—	3	1	2	8	23	16	11	8	11	6	3	3	—	—	2	1	—	—	—	—	—	—	—	1*		
					†	1	—	—	—	2	1	3	6	24	10	17	6	13	7	3	3	—	—	—	3	†									
1400	4°	2½						2	1	3	5	4	9	9	7	12	7	14	10	7	2	3	2	1											
		3						—	—	—	3	3	12	16	9	18	9	8	7	7	2	2	—	1											

This Table is constructed from the Column of Calculated Deflections given in the Report under the head of "Deflections, deducting allowance for Wind."

* This deviation is nearly double any other, and if rejected, as might be done, the deflections would be as inserted in the line below, marked †

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TABLE E.

EXTENT OF IRREGULARITIES IN RANGE AND DIRECTION.

Guns, 9-Pr. Brass. Charges, 2 lbs. and 3 lbs.

Distance of Target.	Elevation.	Charge.	Maximum Range.	Minimum Range.	Differences.	Shot from which the Mean Range was taken.				Greatest Deflections.*	
						Maximum Range.	Minimum Range.	Differences.	No. of Shot rejected.	Left.	Right.
yards.	degrees.	lbs.	yds. ft. in.	yds. ft. in.	yards.	yds. ft. in.	yds. ft. in.	yards.		yds. ft. in.	yds. ft. in.
1000	2°	2½	1177 1 0	798 1 0	379	1089 2 0	798 1 0	291	0.....short 4.....over	19 0 9	25 0 4
		3	1147 2 3	816 1 6	331	1112 2 6	816 1 6	296	0.....short 2.....over	13 0 11	17 2 10
1200	3°	2½	1436 1 0	931 2 0	505	1335 1 6	1003 1 3	332	3.....short 5.....over	18 1 2	21 0 11
		3	1471 1 6	1000 0 6	471	1345 0 0	1006 0 6	345	0.....short 3.....over	20 2 2	17 2 4
1300	3½°	2½	1904 0 0	1063 0 0	841	1488 0 0	1100 1 8	387	3.....short 9.....over	40 2 3	59 0 8
		3	1765 0 0	1088 1 6	677	1540 0 0	1154 0 0	386	1..... short 4.....over	24 1 4	95 0 6†
1400	4°	2½	1900 0 0	1129 2 0	770	1581 0 0	1180 1 0	401	1.....short 10.....over	33 2 5	45 1 4
		3	1802 1 4	1146 1 4	656	1644 2 0	1250 0 0	395	2 .....short 4.....over	24 2 11	39 0 2

Number of Shot rejected in taking Mean Range { 2½ lbs. ... { 7.....short, 28.....over } Total Rejected .....35 ; 3 lbs. ... { 3.....short, 13.....over } .....16 } Out of 400 rounds with each charge.

* These Deflections are taken from those reduced to 1000, 1200, 1300, and 1400 yards respectively.

† The next highest to this is, 54 yds. 2 ft.

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TABLE F.

TABLE OF MEANS.

Guns, 9-Pr. Brass. Charges, 2½ lbs. and 3lbs.

Distance of Target.	Elevation.	Charge.	Mean Range.	Mean Deflection. Left.	Mean Deflection. Right.	Mean Recoil.	Mean Time of Flight.	Mean Range corresponding to Times of Flight.	Mean of the Differences between 1st Grazes.
yards.	degrees.	lbs.	yards.	yds. ft. in.	yds. ft. in.	ft. in.	seconds.	yards.	
1000	2°	2½	926 −44	4 0 8	4 2 2	7 7	not taken	.....	3·83
		3	970	3 1 5	3 1 5	9 8			3·34
1200	3°	2½	1125 −50	5 0 11	5 2 3	6 6½	not taken	.....	5·09
		3	1175	5 2 8	5 1 11	8 3¾			4·76
1300	3½°	2½	1294 −51	11 2 3	12 0 0	6 11¼	4·53	1263	8·49
		3	1345	9 0 7	12 0 4	8 4¼	4·63	1328	6·83
1400	4°	2½	1354 −77	12 1 5	11 1 8	8 2	not taken	.....	7·78
		3	1431	8 1 3	9 2 11	10 1			6·62

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TABLES M.

FIRST GRAZES.

Guns, 9-Pr. Brass. SABOTS (Rivetted and Strapped). Charges, 2½ lbs. and 3 lbs.

Elevation 2 degrees.

	800		850		900		950		1000		1050		1100		1150		1200	
	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.
2½ lbs.	798 798 822	811 818 819 821	844 845 850 867 868	825 837 842 850 850 853 857 869	880 881 883 884 885 889 897 898 901 905 905 908 913 915 916 916 921	876 880 885 891 893 897 899 900 904 907 912 916 920 920	930 932 932 934 943 947 950 950 952 954 964 974	927 930 931 931 935 944 947 950 962 963 967 973	976 1015 1016 1022 1024	983 1002 1010 1017 1018	1029 1049 1050 1066	1030 1042 1050 1050	1083 1089 1123	1082	1139	1132	—	1177
	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.
3 lbs.	816 820	—	873	826 839 863 868	877 882 883 897 908 908 915	895 900 904 910 910 911 919	927 928 950 950 952 955 964 964 967 968	926 927 933 933 933 935 936 938 943 947 947 951 951 960 960 972	975 979 979 981 990 990 991 991 991 991 992 994 1001 1001 1002 1003 1007 1009 1010 1012 1012 1018 1022	978 980 987 999 1002 1003 1006 1011 1016 1019 1021 1022	1026 1029 1031 1032 1072 1073	1025 1028 1033 1043	1080	1076 1077 1082 1109 1112	—	1130 1147	—	—

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Elevation 3 degrees.

	950		1000		1050		1100		1150		1200		1250		1300		1350		1400		1450	
	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.
2½ lbs.	931	966	980 1021	1003 1005 1010 1011 1013 1016 1019	1045 1051 1061 1063 1064 1066 1067 1068 1071 1073	1030 1034 1036 1039 1045 1046 1056 1063	1077 1078 1084 1091 1099 1101 1104 1108 1112 1123	1082 1085 1086 1088 1091 1094 1100 1107 1109 1112 1116 1122 1123 1124	1125 1127 1130 1134 1136 1138 1141 1141 1143 1144 1146 1155 1161 1161 1162 1164 1165 1172	1136 1146 1151 1164 1173 1173	1179 1205 1213 1213	1181 1193 1198 1203 1211	1243	1229 1233	1294 1315	1310 1323	1326	1335 1354	—	1379 1388 1404	1436	—
	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.	Rivet.	Strap.
3 lbs.	—	—	1002	1000 1001	1048 1050 1055	1033	1097 1105 1108 1118 1122	1078 1091 1096 1097 1101 1107 1108 1124	1135 1140 1141 1142 1146 1150 1150 1151 1153 1156 1157 1163 1163 1163 1171 1171 1174	1125 1135 1138 1142 1142 1142 1144 1144 1146 1148 1155 1156	1176 1188 1188 1191 1192 1194 1196 1197 1202 1209 1215 1218	1179 1191 1194 1195 1195 1205 1206 1212 1215 1217	1229 1230 1233 1237 1238 1253 1253 1267 1269	1230 1231 1233 1245 1246 1252 1258 1260 1263 1263	1275	1278	1345	1327 1345 1345	—	1411	1431	1471

The numbers in the Columns denote the first Grazes in yards. Each Column represents 50 yards in range.
The numbers at the head of the Columns denote the distance from the Battery.

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TABLES M.—*Continued.* Elevation 3½ degrees.

	1050		1100		1150		1200		1250		1300		1350		1400		1450		1500		1550		1600		1650		1700		1750		1800		1850		1900	
	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.
2½ lbs.	1063	1069	1110	1075 1100 1119	1125 1143 1152 1152 1152 1155	1173	1200 1203 1206 1211 1212 1216	1178 1188 1192 1192 1198 1198 1209 1212 1220	1238 1240 1242 1243 1247 1257 1259 1262 1269 1273	1225 1228 1232 1242 1257 1261 1265	1279 1287 1289 1297 1300 1302 1306 1310 1315	1275 1279 1283 1289 1311	1325 1331 1337 1338 1341 1371	1325 1330 1346 1362 1371	1382 1389 1389 1401 1405 1408	1376 1377 1380 1391 1395 1395 1400 1423	1442	1431 1434 1438 1469 1470	—	1488	1541 1570	1547 1548 1567	1608	1577	—	1632	—	—	—	—	—	—	—	—	—	1904
3 lbs.	—[1]	—	1088	—	1154	1171	1192 1199 1224	1192 1215 1219	1229 1239 1244 1245 1245 1247 1253 1258 1267 1272	1236 1244 1252 1253 1260 1262 1264 1264 1264	1298 1304 1319 1320 1323 1323	1284 1299 1302 1307 1311 1312 1317 1320	1325 1347 1347 1350 1352 1353 1360 1360 1361 1362 1365 1369	1328 1329 1331 1337 1340 1346 1353 1359 1362 1363	1375 1375 1376 1380 1383 1393 1399 1423	1379 1403 1406 1407 1423 1423	1434 1469 1473	1430 1443 1445 1456 1465	1500 1507 1517 1524	1491 1508 1513	1540 1573	1525 1535	—	—	1638	1670	—	—	—	1765	—	—	—	—	—	—

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Elevation 4 degrees.

	1150		1200		1250		1300		1350		1400		1450		1500		1550		1600		1650		1700		1750		1800		1850		1900	
	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.
24 lbs.	—	1120	1181	1180	1246	1247	1287	1279	1330	1325	1375	1375	1427	1432	1481	1476	1562	—	1591	—	1631	1632	—	1700	—	1730	—	1777	—	—	—	1900
			1205	1182	1247	1254	1283	1289	1339	1329	1379	1276	1451	1446	1494	1502			1593		1673	1647										
			1220	1188	1250	1255	1300	1300	1342	1334	1380	1383	1470	1449	1485	1519			1602													
			1223		1254	1261	1304	1303	1353	1340	1383	1398		1454	1510																	
						1261	1306	1305	1361	1344	1385	1400		1458																		
						1269	1311	1308	1372	1340	1385	1418		1469																		
						1269	1312	1321		1353	1393	1418		1472																		
							1314			1358	1400																					
							1318			1363	1401																					
							1318				1403																					
							1323				1411																					
	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.	Riv.	Str.
3 lbs.	1146	—	1190	—	1262	1247	1291	1298	1329	1332	1377	1380	1428	1425	1482	1490	1540	1525	1600	1590	1644	1641	1698	1716	—	—	—	1802	—	—	—	—
					1265	1254	1301	1299	1333	1345	1378	1394	1436	1442	1494	1496	1658	1531	1604	1597		1642										
					1272	1261	1310	1302	1337	1346	1387	1385	1437	1448	1508	1501		1533	1607	1604		1661										
					1274		1315	1307	1340	1372	1387	1399	1441	1459	1511	1508		1548	1609													
							1316	1309	1371		1393	1400	1446	1459	1520	1511			1613													
								1317			1397	1401	1459	1460	1524	1512																
								1321			1399	1402	1465	1461		1513																
											1418	1403	1469	1472																		
											1420	1404	1471																			
												1417	1473																			

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TABLE N.

FIRST GRAZES.

Guns, 9-Pr. Brass. SABOTS (Rivetted and Strapped). Charges, 2½ lbs. and 3 lbs.

Each Column represents a space of 50 yards of range. The number at the head of each Column is the distance in yards from the Battery, and is the centre of the space represented by that Column. The numbers in the Columns shew the number of shot that fell within each 50 yards.

Target.	Elevation.	Charge.	Sabôts.	800	850	900	950	1000	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900
yards.	degrees.	lbs.																								
1000	2°	2½	Rivetted	3	5	17	12	5	4	3	1	—														
			Strapped	4	8	14	12	5	4	1	1	1														
		3	Rivetted	2	1	7	10	23	6	1	—	—														
			Strapped	—	4	7	16	12	4	5	2	—														
1200	3°	2½	Rivetted				1	2	10	10	18	4	1	2	1	—	1									
			Strapped				1	7	8	14	6	5	2	2	2	3	—									
		3	Rivetted					1	3	5	17	12	9	1	1	—	1									
			Strapped					2	1	9	12	10	10	1	3	1	1									
1300	3½°	2½	Rivetted						1	1	6	6	10	9	6	6	1	—	2	1						
			Strapped						1	3	1	9	7	5	5	8	5	1	3	1	1	—	—	—	—	1
		3	Rivetted							1	1	3	10	6	12	8	3	4	2	—	1					
			Strapped							—	1	3	9	8	10	6	5	3	2	—	1	—	1			
1400	4°	2½	Rivetted								—	4	4	11	6	12	3	4	1	3	2					
			Strapped								1	3	7	7	9	7	7	3	—	—	2	1	1	1	—	1
		3	Rivetted								1	1	4	5	5	9	10	6	2	5	1	1				
			Strapped								—	—	2	7	4	10	8	7	4	3	3	1	—	1		

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TABLE O.

DEFLECTIONS.

Guns, 9-Pr. Brass. SABÔTS (Rivetted and Strapped). Charges, 2½ lbs. and 3 lbs.

The numbers at the head of the Table denote, in yards, the extent of deflections left and right.
The figures in the Columns shew the number of shot that fell within the several distances, denoted at the head of the Table.

Target.	Elevation.	Charge.	Sabôts.	Left. 60	55	50	45	40	35	30	25	20	15	10	5	2	⊙	Right. 2	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
yards.	degrees.	lbs.																																
1000	2°	2½	Rivetted											1	7	7	21	9	2	3														
			Strapped											4	8	8	10	9	9	—	2													
		3	Rivetted											—	4	12	18	9	7	—	—													
			Strapped											—	6	14	13	9	7	1	—													
1200	3°	2½	Rivetted											3	7	7	15	8	6	2	2													
			Strapped											5	11	2	16	7	6	—	1	2												
		3	Rivetted										2	4	3	7	15	7	9	2	1	—												
			Strapped										2	3	5	11	9	8	8	2	—	1												
1300	3½°	2½	Rivetted				1	—	—	—	—	4	5	9	2	11		4	3	4	3	1	2	—	1									
			Strapped			1	—	—	—	1	—	3	1	5	7	10	2	6	2	4	1	1	1	1	—	1	1	1*						
		3	Rivetted								1	—	2	4	11	5	6	3	8	7	2	—	1											
			Strapped			1	—	—	—	—	3	—	1	4	11	10	5	1	5	3	—	2	—	—	2	1	—	—	—	—	—	—	1†		
						§	1	—	—	—	1	1	2	2	9	10	8	2	5	3	—	2	—	—	—	3	§							
1400	4°	2½	Rivetted						1	—	—	1	3	6	4	7	7	4	9	2	4	—	1	1										
			Strapped								2	2	3	7	3	6	4	7	2	2	4	1	3	1	1‡									
		3	Rivetted									2	—	5	7	8	9	4	7	2	1	1	1	1‖										
			Strapped									2	3	5	10	5	3	5	6	4	5	1	—	1										

* One round to the Right, uncertain, which is omitted.
† This deviation is nearly double any other, and if rejected, as might be done, the deflections would be as inserted in the line below, marked §
‡ Two rounds not known. ‖ Ditto.

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TABLE

Result of the Examination of Two 9-Pr. Brass Practice carried on in Plumstead Marshes, 1858.

Gun A.

Mark.	Weight. cwt. qrs. lbs.	Maker.	
H^{24}. 698.	13 2 26.	King, 1819.	

Examined.		Vent. Top.	Vent. Bottom.	Length. Piece.	Length. Bore.	Diameter of Bore.	Thermometer.
		inches.	inches.	ft. inch.	ft. inch.	inches.	
When issued		·222	·222	5 11·53	5 7·82	4·2	
After	100 rounds	·222	·250	5 11·61	5 7·83	4·2	56°
	200 „	·230	·380	5 11·61	5 7·84	4·201	59°
	300 „	·240	·400	5 11·61	5 7·84	4·205	61°
	400 „	·240	·480	5 11·61	5 7·84	4·210	58°

Gun A.

Distance from Face.	DEPRESSIONS IN BORE, AFTER															
	100 rounds.				200 rounds.				300 rounds.				400 rounds.			
	Down.	Up.	Right.	Left.	Down.	Up.	Right.	Left.	Down.	Up.	Right.	Left.	Down.	Up.	Right.	Left.
Muzzle...	...	...	...	...	...	...	...	...	...	·01	...	...	·01	·012	·012	·01
4 inches	...	...	...	...	...	...	...	...	...	...	...	...	...	·01	·01	·01
8 „	...	...	...	...	...	...	...	...	...	...	...	...	...	·01	...	...
34 „	...	...	...	...	...	...	...	...	·01	...	...	...	·01	...	·01	..
40 „	...	...	...	...	...	...	...	...	·01	...	...	...	·01	...	...	...
42 „	...	...	...	...	...	...	...	...	·012	...	...	...	...	·01	...	...
44 „	...	...	...	...	·01	...	...	...	...	...	...	...	·012	...	...	...
48 „	...	...	...	...	...	...	...	...	·012	...	...	...	·012	...	...	...
50 „	...	...	...	...	...	...	.01	...	...	...	·01	...	...	...	·01	...
52 „	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
54 „	·012	...	...	...	·024	...	...	...	·025	·012	·01	...	·025	·012	·01	...
58 „	·02	...	...	...	·025	...	·01	...	·025	...	.01	...	·025	...	·01	...

* The guns were fired with solid shot,

These Examinations were made in the Proof Department of the Royal Gun Factories,

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Z.

Guns, made after each hundred rounds fired from them.*

Gun B.

Mark.	Weight. cwt. qrs. lbs.	Maker.
M^{21}. 534.	13 3 6.	King, 1813.

Examined.	Vent.		Length.		Diameter of Bore.
	Top.	Bottom.	Piece.	Bore.	
	inches.	inches.	ft. inch.	ft. inch.	inches.
When issued	·222	·222	5 11·54	5 7·7	4·2
After 100 rounds	·222	·250	5 11·56	5 7·77	4·2
After 200 „	·230	·310	5 11·56	5 7·78	4·201
After 300 „	·230	·370	5 11·56	5 7·78	4·210
After 400 „	·230	·410	5 11·56	5 7·78	4·210

Gun B.

Distance from Face.	Depressions in bore, after 100 rounds.				200 rounds.				300 rounds.				400 rounds.			
	Down.	Up.	Right.	Left.	Down.	Up.	Right.	Left.	Down.	Up.	Right.	Left.	Down.	Up.	Right.	Left.
Muzzle...	...	...	...	...	...	...	...	...	·01	·012	...	...	·012	·012	...	...
4 inches	...	...	...	...	...	...	...	...	...	·01	...	...	·01	·01	...	...
8 „	...	...	...	...	...	...	...	...	...	...	...	...	·01	...	...	...
24 „	...	...	...	...	...	...	...	...	...	..	...	...	...	...	...	·01
51 „	...	...	...	...	...	...	Slight Graze	...	...	...	Slight Graze	...	...	...	Slight Graze	...
52 „	...	...	...	...	...	...	...	...	...	...	·01	...	·012	·012	·012	...
54 „	...	...	...	...	...	·01	...	...	...	·01	...	·01	...	·025	...	·01
56 „	...	...	...	...	...	...	...	...	·012	·012	...	...	·012	·025	...	...
58 „	·01	...	...	...	·015	...	·01	...	·025	...	·025	...	·025	...	·025	...
60 „	..	...	...	...	...	...	...	...	...	...	...	...	...	...	·01	...

and 2½ lbs. and 3 lbs. charges alternately.

Royal Arsenal, and the results communicated by Colonel Eardley-Wilmot, R.A., Sup^{t}.

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TABLE R.

EXTENT OF IRREGULARITIES IN RANGE AND DIRECTION.

Guns, 9-Pr. Brass. SABOTS (Rivetted and Strapped). Charges, 2½ lbs. and 3 lbs.

Distance of Target.	Elevation.	Charge.	Sabôts.	Maximum Range.	Minimum Range.	Differences.	Shot from which the Mean Range was taken. Maximum Range.	Minimum Range.	Differences.	No. of Shot rejected.	Greatest Deflections.* Left.	Right.
yards.	degrees.	lbs.		yds. ft. in.	yds. ft. in.	yards.	yds. ft. in.	yds. ft. in.	yards.		yds. ft. in.	yds. ft. in.
1000	2°	2½	Rivetted	1139 1 11	798 1 0	341	1089 2 0	798 1 0	291	0.....short 2.....over	11 0 3	21 0 0
			Strapped	1177 0 9	811 1 0	366 −25	1082 1 6	811 1 0	271	0.....short 2.....over	19 0 9	25 0 4
		3	Rivetted	1080 1 0	816 1 6	264	1080 1 0	816 1 6	264	0.....short 0.....over	8 0 5	15 2 9
			Strapped	1147 2 3	826 1 9	321 −57	1112 2 6	826 1 9	286	0.....short 2.....over	13 0 11	17 2 10
1200	3°	2½	Rivetted	1436 1 0	931 2 0	505	1326 0 0	980 1 3	346	1.....short 1.....over	17 2 9	9 2 0
			Strapped	1404 0 6	966 0 8	438 +67	1354 2 0	1003 1 3	351	1.....short 3.....over	18 1 2	21 0 11
		3	Rivetted	1431 2 0	1002 0 9	429	1345 2 5	1002 0 9	344	0.....short 1.....over	18 2 9	13 0 9
			Strapped	1471 1 6	1000 0 6	471 −42	1345 0 0	1000 0 6	345	0.....short 2.....over	20 2 2	17 2 4
1300	3½°	2½	Rivetted	1608 2 8	1063 0 0	546	1442 1 0	1110 0 0	332	1.....short 3.....over	42 0 7	46 1 8
			Strapped	1904 0 0	1069 1 8	834 −288	1488 0 0	1100 1 8	387	2.....short 6.....over	40 2 2	59 0 8
		3	Rivetted	1638 0 0	1088 1 6	550	1540 0 0	1154 0 0	386	1.....short 2.....over	24 1 3	31 1 3
			Strapped	1765 0 0	1171 1 8	593 −43	1535 0 0	1171 1 8	364	0.....short 2.....over	36 0 6	95 0 5
1400	4°	2½	Rivetted	1673 0 3	1181 0 0	492	1602 0 4	1205 0 2	397	1.....short 2.....over	29 1 4	41 2 6
			Strapped	1900 0 0	1129 2 0	770 −278	1647 0 0	1247 2 5	399	4.....short 4.....over	33 2 5	45 1 4
		3	Rivetted	1698 2 0	1146 1 4	552	1644 2 0	1250 0 0	395	2.....short 1.....over	24 2 11	42 0 7
			Strapped	1802 1 4	1262 2 0	540 +12	1661 0 0	1262 2 0	398	0.....short 2.....over	17 2 1	39 0 2

Number of Shot rejected in taking the Mean Range

			Total Rejected.
2½ lbs.	Rivetted ...	3.....short 8.....over	11
	Strapped ...	7.....short 15.....over	22
3 lbs.	Rivetted ...	3.....short 4.....over	 7
	Strapped ...	0.....short 8.....over	 8

* These Deflections are taken from those reduced to 1000, 1200, 1300, and 1400 yards respectively.

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TABLE S.

TABLE OF MEANS.

(Vide p. 8).

Guns, 9-Pr. Brass. SABOTS (Rivetted and Strapped). Charges, 2½ lbs. and 3 lbs.

Distance of Target.	Elevation.	Charge.	Sabots.	Mean Range.	Mean Deflection. Left.	Mean Deflection. Right.	Mean Time of Flight.	Mean Range corresponding to Times of Flight.	Mean of the Differences in 1st Grazes.
yards.	degrees.	lbs.		yards.	yds. ft. in.	yds. ft. in.	seconds.	yards.	
1000	2°	2½	Rivetted	929	4 1 11	3 0 4	not taken	.....	6·96
			Strapped	924 +5	6 0 8	4 0 6			7·46
		3	Rivetted	972	2 2 0	3 2 0	not taken	.....	5·38
			Strapped	968 +4	3 1 0	3 2 7			6·75
1200	3°	2½	Rivetted	1130	5 0 6	4 2 4	not taken	.....	10·29
			Strapped	1122 +8	5 1 3	6 0 0			8·93
		3	Rivetted	1174	5 1 4	5 0 0	not taken	.....	8·76
			Strapped	1176 −2	5 2 7	5 2 8			9·19
1300	3½°	2½	Rivetted	1272	9 2 4	10 1 10	4·45*	1263·1·0	11·14
			Strapped	1318 −46	11 0 7	16 0 8	4·64	1262·1·0	17·03
		3	Rivetted	1339	7 2 4	9 0 5	4·55	1310·1·3	11·21
			Strapped	1351 −12	10 0 10	16 2 4	4·71	1346·1·7	12·11
1400	4°	2½	Rivetted	1390	10 1 2	8 2 7	not taken	.....	10·04
			Strapped	1355 +35	12 0 1	13 0 2			15·72
		3	Rivetted	1430	7 0 6	8 1 3	not taken	.....	11.26
			Strapped	1437 −7	9 0 1	11 1 6			11·21

* Taking 4½ seconds for the Time of Flight, Elevation 3½°, the comparative results would be, or nearly so .....

		yds.
2½ lbs. ...	Rivetted	1277·5
	Strapped	1223·8
3 lbs. ...	Rivetted	1294·6
	Strapped	1285·3

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The Secretary of State for War, in authorizing the publication of Captain Haultain's Report, by the Royal Artillery Institution, desired that the reasons given by the Select Committee for adhering to the present charge for the 9-pr. gun should be added to the Report. These reasons are given in the following letter :—

ORDNANCE SELECT COMMITTEE,

May 6, 1859.

SIR,

In reply to your communication of the 2nd instant, enclosing a copy of a letter received by you from the Secretary of State for War, relative to the publication, in the "Proceedings of the Royal Artillery Institution," Captain Haultain's Report on Practice with 9-pr. Brass Guns, and authorizing you to obtain from Colonel Pickering, the reasons given by the Committee for adhering to the present charge of 2½ lbs. for 9-pr. Field Guns, I am directed to inform you, that the Committee were of opinion that the results arrived at in the experiments carried out by Captain Haultain, were not so sufficiently conclusive on all points, as to induce the Committee to recommend a change in the charge of the 9-pr. Gun, which involves so serious a question as the durability of the gun and carriage.

The reduction of the charge from 3 lbs. to 2½ lbs., was made in the year 1843, in consequence of the windage of Field Guns being considerably diminished at that period.

I have the honor to be,
Sir,
Your obedient Servant,
F. A. CAMPBELL,
Lieut.-Colonel, R.A.,
Assistant-Secretary.

Captain Noble,
Secy. R. A. Institution.

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A Synopsis of American experiments on the Strength and other Properties of Metal for Cannon, selected and abridged from the Official Reports made at the different Foundries in the United States. By Major M'Crea, R.A.

The bursting of the large gun of the "Princeton," American war steamer, thirteen years ago, caused the United States Government to institute a series of investigations on the properties of metal for cannon. This resulted at once in the discovery that, in the unfortunate gun alluded to, while the metal bore only one-third the strain of English bars of average quality, portions of it when reworked, stood a tensile force nearly equal to that borne to the best hammered iron of American make.

The experiments on the tensile strength and specific gravity of the metal are exceedingly numerous, and appear to have been conducted with great care. The plan pursued with all new ordnance, when manufacturing castings in which a high tensile strength is demanded, was to take pieces of metal from the gunhead, as fairly representing the quality where the casting had been effected with a single charge, and turned in a lathe to the section and size fitting the testing machine. A record of the strain borne by the trial piece of each gun was kept, and forms the substance of the reports. Whenever the tensile strength fell below 20,000 lbs. the square inch, the quality was pronounced bad, and the gun unfit for service.

The effect of remelting the iron was shown in an augmentation of the specific gravity from about 7·000 to 7·320, and an increase in the tenacity from 20,000 lbs. to 38,000 lbs. the square inch. Although in an extensive series of experiments, one or two exceptions are to be found, the dependance of superior tensile properties on a high density of the metal is very well borne out, and confirms the correctness of the views advanced by several English experimenters. But for the attainment of this high tensile strength, the iron requires to be remelted twice, and in some instances three times. An equally great improvement is obtained through keeping the iron in fusion for longer periods than usual. Thus, pig-iron remelted, and fifteen minutes in fusion, bore a strain of 20,336 lbs. The same iron

2¼	hours in fusion bore a strain of	27,456 lbs.
4¼	.....	29,227 „
6¾	.....	36,312 „
7¾	.....	37,552 „ the square inch.

The density rose from 7·175 in the first to 7·343 in the last experiment. These figures are corroborative of the opinion by English manufacturers, that mere exposure to a reverberating column of hot air, either by repeated fusions, or by a prolonged exposure, results in a refining of the molten iron through the combustion of the carbon, and partial separation of the alloyed matters. The process, however, is applicable only to dark gray varieties of pig-iron; bright gray pigs bear only a limited exposure; and

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though their density is increased to 7·400 by lengthening the refining, their tenacity suffers a large diminution.

Experiments were made on the comparative strength of iron slowly cooled, and small castings cooled rapidly. Several guns were subjected to hydraulic pressure; and it is worthy of remark, at pressures of 9000 lbs. and upwards, the water issued from the metal in innumerable fine jets; showing that in the metal of cast-iron guns, a peculiar alteration of structure took place when subjected to this pressure.

In all the experiments, hot blast-iron was found greatly inferior to cold in point of density and tenacity; so much so that in some contracts, where hot blast-iron had been used, more than one-half of the guns burst under the proof fire. In no instance did the hot air smelted metal approach the tenacity essential to the durability and safety of heavy ordnance; a circumstance which led the American Government to prohibit its use in all subsequent contracts.

Believing that a perusal of the Reports would be worthy of the attention of English artillerymen, the experiments have been carefully condensed and abridged, and are thus offered to the use of the regiment.

EXPERIMENT, No. 1.

Four six iron pounder guns were cast February 15, 1844, at South Boston Foundry. The furnace was charged with 11,000 lbs.; one half of which consisted of remelted iron, which had been continued four hours in fusion at the first melting; the other half of fresh pigs from the smelting furnace. The order of casting was as follows:—

No. 1, cast after the iron had been in fusion ½ hour.
2 - - - - 1½ „
3 - - - - 3 „
4 - - - - 3¾ „

The casting was very satisfactory. The castings remained in the moulds embedded in the earth 3½ days after casting.

The scale of charges was arranged, that each in succession would be of greater force than that immediately preceding, until the maximum was reached, when the latter would be repeated till the end. As the greatest force produced by any charge is exerted upon that part of the bore which is situated between the centre of the first ball and bottom of the bore, it was thought best to use moderately small charges, and to augment the force of the charge by the addition of balls. The charge of powder used was 2½ lbs., increased to the 3 lbs., with as many balls as the gun might contain.

It having been found in former trials with high charges, that the common round balls were frequently crushed and wedged within the bore of the gun; thereby developing unequal and greater forces than is caused by the weight of the projectile, the balls were now cast in pairs, the two balls being connected by a cylinder, the diameter of which is equal to three-fourths the diameter of the balls. The ends of the pair are planes perpendicular to the axis, and of the same diameter as the connecting cylinder. The windage and weight of the pair are the same as of two spherical balls. They occupy

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less space in the gun than an equal number of round balls, so that a greater number of the former may be used in a maximum proof charge.

This method of casting the balls in pairs has proved entirely successful; no instance of their having been crushed within the gun has been discovered.

With balls of this form, wads, which always cause an uncertain amount of resistance are not necessary.

The service charge of this gun is 1¼ lb.

Summary of Results.

Guns.	Iron in fusion hours.	No. of fires made.	Powder used pounds.	Number of balls discharged.	Endurance.
1	½	31	75	367	Burst 31st fire.
2	1½	34	84	415	... 34th ...
3	3	38	102	461	Remains unbroken.
4	3¼	25	57	271	Burst 28th fire.

All these four guns reached the maximum charge of 3 lbs. of powder, and 16 balls. No. 1, burst at the ninth *full* charge; No. 2, at the twelfth; No. 4, at the third; while No. 3 endured the maximum charges, also two other heavy charges of a different kind, and remained unbroken,—6 lbs. of powder and 7 balls.

The relative endurance of these four guns follows the order of the relative duration in fusion, of the iron composing each, up to and including the third gun, cast when the iron had been three hours in fusion.

The fourth gun cast three-fourths of an hour after the third, proves to be the weakest of the whole number. No imperfection or defect was observed that could account for its possessing less strength than either of the others; its bursting therefore at an earlier period can be attributed to no other cause, than that of the iron having been continued in fusion for a longer period of time.

These results appear satisfactorily to establish the facts, that a prolonged exposure of liquid iron to an intense heat, does augment the cohesive power of the iron; and that this power increases as the times of exposure, up to some (not well ascertained) limit; and that if extended beyond that limit, the strength of the iron is thereby diminished.

All these guns endured a very high proof. It was ascertained that the bores were sensibly enlarged by the firing, and that the enlargement was greatest a little below the line where the cartridge and the first ball meet, diminishing from that line in either direction.

Gun No. 3, was measured at different periods of the firing.

The enlargement at the 23rd fire was ·008 in.
„ 28th „ ·011 —
„ 33rd „ ·015 —
„ 38th „ ·018 —

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Gun No. 2 at the thirty-third fire, the last one previous to its bursting had enlarged ·025 in.

The vents also were considerably enlarged.

In gun No. 3 the diameter of the vent increased from ·18 to ·32 inch at exterior orifice.

South Boston Foundry,
March 16, 1844.

EXPERIMENT, No. 2.

Experiments were made in South Boston Foundry, in April 1844, to determine the transverse strength of different kinds of cast-iron, and of the same kinds cast under different circumstances of temperature, and of exposure in fusion.

The bars were cast 24 inches long, and 2 inches square; when tried they were supported on both ends on knife edges, which were 20 inches apart.

Bars, alloyed with zinc, were also tried, unsuccessfully.

The results showed generally a gradual and positive increase of strength, as the iron is continued in fusion for longer periods of time.

The iron used was taken from various furnaces.

The first fusion denotes the original pig, as made at the smelting furnace from the ore.

The second fusion denotes iron, which has been once melted in the foundry furnace.

The third fusion, such iron as has been twice melted at the foundry.

A 10-inch gun was cast at the same time, and affords a good example of the effect; as in this case, numerous bars were taken on four different days from the same parcel of iron, in all its different stages of the second and third fusion, from the first melting of the pigs to the casting of the gun.

The following gives a brief view of these results :—

Second Fusion.

	Strength.	Ratio.
First casting made as soon as the pig-iron was melted	6506	1000
Second casting. Iron in fusion one hour	7316	1124
Third do. two hours	8256	1269
Fourth do. three hours	8378	1287

Third Fusion.

	Strength.	Ratio.
Seventh casting. Iron in second fusion 1¾ hours, whole time in fusion 4¾ hours	10411	1600

From this it appears that the cohesive power of the iron, so far as it can be shown by its capacity to resist transverse strains is increased by its continued exposure in fusion from 100 to 160,—or 60 per cent.

The transverse strength is that most generally measured, when determining the quality of different materials.

A more accurate measure of the cohesive power of iron designed for cannon might be found in its *tensile* strength; that is, its power to resist

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being torn asunder by a force exerted by a breaking instrument in the direction of its length.

EXPERIMENT, No. 3.

At Washington, on October 12, 1844, a report was made on the strength and density of cast-iron; also a report of the experiments made to ascertain the durability of new model heavy 8 and 10-in. howitzers, under continuous firing with service charges. A report of the experiments made in the extreme proof of cannon under hydrostatic pressure; and a report of an examination of the iron used in the construction of the wrought-iron cannon, which burst on board of the steam ship "Princeton," Feb. 28, 1844.

The experiments supplied much information of a practically useful character. A breaking machine was used which determined the tenacity of iron, in either of the forms of tension or of transverse breaking, furnishing a convenient and accurate mode of testing the quality of iron before it is used in casting cannon. It enables the founder to select his materials for cannon with greater certainty and safety; also, to determine the comparative utility of the different methods of melting and casting the iron. The results proved that the quality of iron is essentially changed, by the different methods of treating it while in the melted state, and by different methods of cooling it after it is cast into the moulds. It proved also that the same iron is greatly improved in quality by retaining it in the furnace after it is melted, for considerable periods of time; and that it is further improved by casting it into pigs, and again remelting it. Moreover, it proved that a continuation of this process ultimately impaired the tenacity of the iron, and rendered it wholly unfit for use; also that different kinds of iron required different treatment, in order to produce the best effect, in their several stages of progress.

A comparison of proof bars cut from the body of the gun, with those cast at the same time in vertical dry sand moulds, showed in every instance that the transverse strength is augmented by rapid cooling in small castings, and that the tensile strength is increased by slow cooling in larger masses. The differences in specific gravity are less marked, but it is somewhat higher in the small castings cooled rapidly.

In selecting specimens for testing by the breaking machine, it was found that samples cut from the trunnions were not reliable for giving a true measure of the quality of the metal in the body of the gun. They were afterwards taken from the face of the muzzle.

Report of the examination of the iron used in the construction of the wrought-iron cannon, which burst on board of the steam ship "Princeton," Feb. 28, 1844.

Two bars of iron taken from the same parcel, and supposed to be of the same quality as that used in the construction of the gun were furnished by the manufacturer. Another bar was cut from the body of the gun itself, as a representative of the quality of the iron as it existed in the gun at the time of its bursting. With these three bars, the following trials were made:—

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The bar cut from the body of the gun was reduced in a planing machine to 2 inches square, and subjected to a transverse strain, supported at both ends on knife edges, 20 inches apart, and the weight applied in the middle. The different weights applied with the deflections and the permanent set caused thereby, were as follows:—

	Weights applied.	Deflection.	Permanent set.
From	10,800 lbs.	·35-inches	·30-inches
To	17,300 „	1·83 „	1·75 „

The bar endured this strain without exhibiting any cracks or other indications of approaching rupture. One of the original bars having the same dimensions, was tried in like manner with similar results.

By these trials, it appears that so far as the quality of stiffness is concerned, the iron has undergone no perceptible change in the process of forging the gun. Trials of bars of cast-iron of same dimensions, prove that the weights sustained by cast-iron of good quality, such as is used in casting iron, range for 14,000 to 17,000 lbs. On comparing these results, it appears that the weight required to break a bar of cast-iron by transverse strain, will bend a bar of wrought-iron of like dimensions, and give it a permanent set varying from 1 to 1¾-inches; and also, that a considerable permanent set is imparted to the wrought-iron bar by weights much less than the minimum breaking weight for cast-iron.

To determine the tensile strength of the iron, or its power to resist being torn asunder by a force applied in the direction of the length of a bar, three specimens were taken from each of the bars mentioned. Two of the specimens taken from each bar were reduced to a suitable form for breaking by tension, in a turning lathe, in order to leave the material in the same state as it existed in the bars, undisturbed by any heating or hammering. The third specimen from each bar was drawn down under a welding heat, at a common smith's forge. All of them were reduced at that part where the fracture would occur to a uniform diameter of six-tenths of an inch. The following results were obtained:—

From the original bars representing the quality of iron before being welded in the fagot for the gun,

	Pounds per square inch.
Mean of six specimens	46,086

From the bar cut from the body of the gun,

Mean of two specimens.....	38,595

One specimen from the same bar drawn under a welding heat 52,521.

It was observed the bars began to yield, by extending in length and contracting in diameter, at about two-thirds the breaking weight.

The original diameter of each specimen was	·6 inch
The diameter under the maximum force was	·55 „
„ when the bars broke	·50 „

In order to compare the iron used in the "Princeton's" guns with other kinds of wrought-iron, additional specimens were tested, as follows:—

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		Pounds per square inch.	Proportional Strength.
Russian iron		62,644	1,0000
English iron:—			
Bankes'		56,532	·9042
Lowmoor		56,103	·8955
American iron		53,913	·8605
"Princeton's" Gun	Original bars as in the gun	46,086	·7356
		38,595	·6166
	Same reworked	52,521	·8383.

The results of this examination appear to show, that the iron used in forging the "Princeton's" gun was originally of an inferior quality, having only about ¾ths the strength of English iron. It appears also, the original strength of the iron is considerably impaired by the process of welding it into so large a mass as that which formed the gun; the strength before and after welding being about 6 to 5.

The wrought-iron cut from the body of the "Princeton's" gun, began to stretch and to contract in diameter when under a pressure of about 25,000 lbs. per square inch; and that force gave it a new form by a permanent extension and set. Numerous trials have proved, that the tensile strength of cast-iron suitable for cannon, will sustain a pressure from 25,000 to 34,000 per square inch.

In 1844, three reports were issued from the arsenal at Boston, of experiments to ascertain the durability of 8-in. and 10-in. "Columbiads," by continuous firing with service charges.

In report, No. 1, dated July 25, 1844, it was stated, that 600 rounds were fired with the 8-in. gun, with 10 lbs. of powder, and one solid ball of 64 lbs. With the 10-in. gun, 200 fires were made with 18 lbs. of powder, and one solid ball weighing 125 lbs. At the conclusion, the bores were found to be enlarged from the centre of the ball forward, and chiefly on the upper side over the ball. The enlargement was greatest half an inch in front of the ball's centre, and its termination was about three inches in front of that point. From the results, it appeared that about 450 fires of the 8-in., and about 300 of the 10-in. were about the number of fires which these guns would endure, before the bores became enlarged beyond the limits allowable in new guns. The bores in all other parts remained unaltered, and as perfect as when first fired.

The original diameters of the vents were ·175 at the interior orifice, and ·180 at the exterior; the vent of the 8-in. gun enlarged to about half an inch in diameter; and the 10-in. gun to about one-fourth of an inch; with these exceptions, both guns were safe and fit for service.

In report, No. 2, dated October 5, 1844, it was stated that the firing of these guns was resumed with the same charges. The number of rounds was completed in the 10-in. gun up to 600. The 8-in. gun burst at the 729th fire, splitting in a vertical plane through the centre; the fissure passing through the breech and reinforce to the rear of the trunnions, where the line of fracture divided, diverging to the right and left, and passed out the chase, about twelve inches in front of the trunnions. The fragments consisting of three pieces only.

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On examination of the 8-inch gun after it burst, the surface of the bore over the ball appeared to have been cut or worn away in furrows by the flame, and unconsumed portions of the charge in the passage over the ball. The lower surface of the bore under the ball was smooth and planished, as if caused by the pressure of the ball on it in its first movements. There were no indications in any part of the bore of any indentations caused by the compression or bounding of the ball. The 10-inch gun remained unbroken.

These heavy chambered guns are of recent date, and our knowledge of their powers, and of their safety and service is yet limited and imperfect, and it is yet to be ascertained what weight and proportions are most suitable for them. The manner in which the 8-inch gun broke has shown, as in all previous trials, that the weakest point is in that part which surrounds the charge.

Report No. 3 is dated Dec. 11, 1844, and contains further experiments to ascertain the durability of the new model heavy 10-inch "Columbiads."

At the date of the last report, the 10-inch gun had been fired 600 times with service charges. The further proof was resumed with a series of gradually increasing charges. From the first fire with 20 lbs. of powder and one ball, to the tenth fire with 22 lbs. of powder and five balls; when the gun burst, splitting through the vent, much in the same manner as the 8-inch gun, leaving the greater part of the chase entire and unbroken.

On the 5th of October, 1844, a report was issued from the Boston foundry of the extreme proof of cannon under hydrostatic pressure.

The first experiment was made upon an old 18-pounder gun, 9 ft. long, and weighing 4214 lbs. The gun was filled with water, and the force pump worked; when at 7000 lbs. pressure per square inch, the water came through the pores of the metal. At a pressure of 9000 lbs. the gun burst.

Another 18-pounder of the same model was then tried. This gun split in two seams at a pressure of 9,860 lbs. per square inch.

Then, in order to obtain some idea of the relation existing between the strains of fired gunpowder, and by the pressure of water, another 18-pounder gun of the same model and weight was tried with powder and balls. The system of proof adopted was 9 lbs. of powder, constant; the first fire with one ball, the second with two balls, the third with three balls. At the fourth fire, with 9 lbs. of powder and four balls, the gun burst.

Proof bars, two feet long, were cut from each of the broken 18-pounder guns, and were dressed in a planing machine to 2-inches square. No 3 is the gun which burst by firing.

Nos.	Transverse strength.	Tensile strength.	Hydrostatic pressure.		Specific gravity.
			In the bore.	Per inch of fracture.	
1	7590	27359	9000	9000	7·312
2	7135	22204	9860	6079	7·328
3	7386	16849	...	...	7·384

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These guns were all of the same model and weight. The iron in all was of the same appearance—light colour, hard and close grained. They differ in degrees of hardness; No. 1 being of the least, and No. 3 the greatest; the latter was difficult to cut with the turning tool, and could not be cut at all with the file. The transverse strength of all the specimens is considerably below the average of good iron. The relative strength of each is more accurately indicated in the column of tensile strength which gives a direct and certain measure of the cohesive power of each. No. 3 is much the weakest of the three specimens tried; and either of the other two guns would, no doubt, have endured a greater number of fires.

The relation between the force applied in producing a fracture in cast-iron by a tensile strain in the axis of the specimen, and by that of hydrostatic pressure within the bore, appears to be somewhat greater than as 3 to 1.

On the 9th December, 1844, a report was made of the trial by water pressure, of a 6-pounder, which on the previous March, had endured the highest proof, and remained unbroken.

The gun was divided into three parts. The first included all in rear of the front of the trunnions, retaining its original form; that portion of it which surrounds the cartridge is cylindrical, and the thickness of metal is there exactly equal to diameter of the bore. The second part extended from the trunnions half way to the muzzle, and was reduced to a cylinder, the thickness of metal in which was just half the diameter of the bore. The third part was also cylindrical, and extended from the second to the muzzle. The thickness of metal in this part is one-fourth the diameter of the bore. At the junctions of the several cylinders, a groove was cut into the metal, reducing the thickness of the metal below it to two-thirds of the thickness of the cylinder in front. This was done in the expectation that in the bursting of one cylinder, the fissures would not extend into the larger one next in succession.

On the first trial, the pressure was raised to 12,400 lbs. per square inch, when the smallest cylinder next the muzzle burst in four fissures.

The piston was next inserted in the middle cylinder, in which the thickness of metal is half a calibre; when at a pressure, estimated at 20,000 lbs. per square inch, the gun burst.

Several proof bars were cut from the fragments of the gun, and tried in the breaking instruments, with the following results:—

Transverse Strength.

Breaking weight.....	16,200 lbs.
Breadth and depth of bar	2 inches.
Length between supports	20 „

Tensile Strength.

Mean of three trials of bar ..... 33,226 lbs. per square inch.

The relation between the tenacity of iron when measured by its power of resisting a direct tensile strain, and when measured by its resistance under

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pressure of water within the bores of cylinders of different thicknesses, appears from these results to be as follows:—

	Tenacity.	Pounds per in.	Proportions.
By direct tensile force		33,226	1·000
By water pressure	thickness = ½ radius	24,800	0·742
	thickness = radius	20,000	0·602

In determining the resistance of water pressure, the force per square inch on the water within the bore is multiplied by the radius of the bore, and the product is divided by the thickness of the iron.

It appears from these results, that the power of resisting in cylinders of the same quality of iron, and of the same diameter of bore, but of a different thickness varies as the thickness, but in a less ratio.

Hence, the increase, or the diminution of the thickness of iron in a gun, does not increase or diminish the strength in like proportion. The results obtained by water pressure from former trials, with these now obtained from the 6-pr. gun, are given in the following Table:—

Kind of iron.	By testing instrument.		By water pressure per square inch.		Thickness of iron in parts of radius of the bore.	Ratio of resistance by water pressure, the tensile strength being the unit 1,000.
	Transverse strength.	Tensile strength per square inch.	Within the bore.	On the area of fracture.		
18-pr. No. 1	7590	27350	9000	9000	1·000	0·329
— No. 2	7135	22204	9860	6082	1·621	0.273
6-pr.	9974	33226	12400 20000	24800 20000	0·500 1·000	0·742 0·602

The results exhibited in this table are remarkable, chiefly for the great difference shown in the quality of iron to be found in cannon, varying in some instances as 3 to 1. They show also that each gun maintains the same comparative character in the order of strength, in each and all the forms of trial.

In October, 1846, experiments were carried on with a new 12-inch Columbiad, cast at the South Boston Foundry. The following remarks are extracted from the report:—

"Among the trials made there were three fires at 35° elevation, and with cartridges of 20 lbs. The average range of these fires was 5,330 yards.

93 fires in all were made with various charges and elevations. At the end of the practice,

The greatest enlargement of the bore at the lodgement of the shell was		·074
Length of indentation		3·0
Enlargement of chamber		·005
„ vent		imperceptible.
Recoil	Horizontal with 20 lbs. charge	4 ft.
	„ 25 lbs. charge	6½ ft.
	At 10° and 15°, about	3 „
	At 35° and 39° „	2 „

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The maximum range in ricochet fires was 3,800 yards, obtained with 20 lbs. of powder, and shells weighing 150 lbs. Charges of 20 lbs., and shells of 150 lbs. were found most suitable for all elevations within 15°, and for all ranges within 4000 yards.

Charges of 25 lbs. and shells of 170 lbs. are most suitable for extreme range at high elevations.

The maximum range of all the fires, 5,800 yards was given by a charge of 28 lbs. and a shell of 181 lbs.

The carriage remained uninjured in any way, permitting the gun to be elevated or depressed throughout its range of 40 degrees, with ease and celerity.

A cap of sheet lead which was placed over the vent of the fuze on the exterior of the shell, appeared to be an effectual preventive to accidental or premature explosion of shells while exposed in the batteries.

One of the shells, through the negligence of the gunner, was fired without this lead cap having been removed; several days after the same shell was dug out of the wet earth more than 2½ miles distant from the gun; and its charge, fuze, and cap, were found undisturbed and in good order for service. The shell was used again with the same fuze and charge, with its lead cap removed, when it exploded at the proper time!

Experiment made to determine the effect produced on the quality of iron in guns by slow or rapid cooling, of the casting, made at South Boston Foundry, April 16, 1847.

Three six-pounder cannon were cast at the same time from the same melting of iron, and in similar moulds. That in which gun No. 1 was cast, was heated before casting, and kept heated afterwards by a fire which surrounded it. Guns Nos. 2 and 3 were cast and cooled in the usual manner. A sheet-iron cylinder lined with brick, enveloped the flask of No. 1, leaving a circular space between for fuel of about 9 inches wide. Grates were placed at the bottom of this space with an ash pit beneath for the admission of air to the fuel.

A charcoal fire was lighted an hour before casting, so that the flask and mould were nearly red hot at the time of casting the gun. The fire was steadily continued for three days, when it was permitted to subside gradually.

At the end of the fourth day, the gun and flask were withdrawn from the heating cylinder; while all the parts were yet quite hot. The next day the mould was removed from the casting; and guns Nos. 1 and 2, bored for 6-pounders in the usual way.

They were then fired with charges of gradually increasing force up to 3 lbs. of powder, and 16 balls, when No. 1 burst at the 27th fire, and No. 2 at the 25th fire.

The general results on the after examination, shewed that no material effect was produced on the quality of the iron by these different methods of cooling the castings.

On the 17th January, 1848, at the South Boston Foundry, an experiment was made to determine the effect produced on the quality of iron in

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guns, by an atmospheric pressure on the surface of the iron while passing from the liquid to the solid state.

Two six-pounders were cast at the same time from the same melting of iron. The moulds were similar, excepting that in one of them a hollow cylinder with one end closed, was inserted in the top of the mould in such a manner as to enclose an air-tight space over the upper surface of the liquid iron.

In casting the gun, the iron entered at the bottom and flowed up until it nearly filled the mould, leaving a few inches of space between the surface of the iron, and the closed top of the mould. The air contained in this space expands by the heat it receives from the liquid iron, and presses upon the latter with a force proportioned to the increased temperature of the air. In addition to the pressure thus produced, additional air was injected into the mould after casting by means of a force pump; while a safety-valve on the top of the mould guarded against injury from excessive pressure.

These means, however, failed to produce so great a pressure as was desired. The greatest pressure obtained was about 4 lbs. per square inch, equal to a head of liquid iron of 15 inches height. The gun cast in the open mould in the usual manner is marked *A*; that cast in the closed mould *B*. They were both proved in the usual manner with gradually increasing charges up to 3 lbs. of powder and 16 balls. *A* burst at the 23rd fire, being the first fire with the maximum charge; *B* burst at the 25th fire, having previously endured four maximum charges.

Specimens from the sinking heads were also tested. All the results exhibited are uniform, though not a very considerable difference in favor of the gun cast under an atmospheric pressure.

The different circumstances under which the two castings cooled, probably had some influence on the quality of the iron. In that cast in the usual manner, the heat in the liquid iron passed off freely in ascending currents through the open top of the mould. In the closed mould, a body of confined air and of dry clay, enclosed in an iron case, intercepted these currents, and obstructed the escape of heat in this upward direction; and no doubt, caused this casting to cool not only more slowly, but also more uniformly in all its parts.

Report on the manufacture and extreme proof of two 8-in. Columbiads; one cast solid and cooled from the exterior, the other cast hollow and cooled from the interior, Oct. 26, 1849.

Two eight-inch Columbiads were cast at the same time from the same iron, one of them (No. 1) was cast solid in the usual manner; the other (No. 2) was cast according to the plan, invented by Lieutenant Rodman, on a hollow core, through which a stream of water passed while the metal was cooling. The iron for both castings was melted at the same time in two air furnaces, each containing 14,000 lbs. of the same kinds of iron.

After melting, the liquid iron remained in the furnace one hour exposed to a high heat, and was discharged by separate streams into a common reservoir. From the reservoir it issued in a single stream which, after proceeding a few feet, separated into two branches, each leading to a separate mould, which were thus filled at the same time.

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The solid casting remained in an open pit, and cooled in the usual manner.

The hollow casting was cooled in the interior, by passing a stream of water through the core, for a period of 40 hours when the core was withdrawn; after which the water passed through the interior cavity caused by the core for 20 hours. The average quantity of water passed through during the whole period was 1·66 cubic feet per minute, or 100 feet per hour, making in all 6000 cubic feet, weighing 187 tons. The temperature of the water was increased 20 degrees during the first hour; thirteen degrees during the twentieth hour; eight degrees during the fortieth hour, and 3 degrees during the sixtieth, and last hour. The mould for this casting was placed in a covered pit, which had been previously heated to about 400 degrees; and this heat was kept up as long as the stream of water was supplied.

Both Columbiads when completed, were found to be accurate and uniform in their dimensions and weights.

The charges used in the proof were as follows :—

Proof charges, 1st fire 12 lbs. powder, 1 ball, 1 wad.
„ 2nd „ 15 „ 1 shell, 1 sabôt.
Service charges, 10 lbs. powder, 1 ball, and 1 sabôt.
Mean weight of balls used 63½ pounds.
„ shells 49 „

Nine full service charges were first fired, and then the two prescribed proof charges; afterwards, service charges again to the end.

Columbiad No. 1 cast solid, burst at the 85th fire.
„ No. 2 cast hollow, burst at the 251st fire.

Both guns split through the breech and reinforce in nearly equal parts.

Samples were taken from the sinking heads, and also from the fragments after bursting. In the tested results there was nothing worthy of special note, other than that they were generally of a low order, especially in their density. The tenacity, however, of the samples was considerably lower in No 1, and higher in No. 2 than the general mean. This difference, though not of large amount, and the difference of the indentations and enlargements of the bores by firing are both in favor of the gun cast hollow, but they are not sufficient to account satisfactorily for the strongly marked difference in the endurance of the two guns.

No other cause for this unequal endurance can be perceived, but that of the different methods by which the castings were cooled. Neither of the guns, however, endured a sufficient number of fires to be satisfactory, and further experiments were recommended.

Extracts from the Report on the manufacture and proof of 8-*in. and* 10-*in. Columbiads, cast in* 1851.

Two 8-inch Columbiads were cast in July, 1851.

After melting, the liquid iron remained in the furnaces two and a half hours exposed to a high heat, and was then discharged into the moulds, filling both moulds at the same time.

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Both of the moulds were placed in open pits; one of the castings was made solid, and cooled in the usual manner, without heating or covering the pit; the other was cast hollow, by means of a core formed on a tube of cast-iron, through which a stream of water constantly circulates while the iron is cooling. The core tube is water-tight, and is closed at the lower end. The water is conducted to the bottom of the core through an interior tube placed in the centre of the core, and open at its lower end. It ascends through the annular space between the two tubes, and is discharged from the core at a point above the casting, and flows off in a heated state.

A fire was kindled in the bottom of the pit directly after casting, and was continued sixty hours. The pit was covered, and the iron case containing the gun mould was kept at as high a temperature as it would safely bear, being nearly at a red heat all the time. The water passed through the core at the rate of two and a half cubic feet per minute. At twenty-five hours after casting the core was withdrawn, and the water thereafter circulated through the interior cavity formed by the core, at the same rate for forty hours, making sixty-five hours in all. The whole quantity of water passed through the casting was nearly 10,000 cubic feet; and the heat imparted by the casting to the water, and carried off by the latter was equal to 6° on the whole quantity of water used.

Two 10-inch Columbiads were cast in August also. The liquid iron remained in fusion 2¼ hours, and was discharged into lower ends of both moulds at the same time. Both moulds were placed in the same pit. One of the guns was cast solid, the other was cast on a hollow core, and cooled within by a stream of water circulating through it, as before described. All of the space within the pit outside of the moulds was filled with moulding-sand and rammed. This was done, because the iron cases of the moulds were not large enough to admit the usual thickness of clay in the walls of the mould. It was apprehended that the heat of the great mass of the iron within would penetrate through the thin mould, and heat the iron cases so much as to cause them to yield, and let the iron run out of the mould. Consequently, the exterior of the mould of the 10-inch hollow gun, instead of being exposed to heated air while cooling, as was the case in the 8-inch hollow gun, was surrounded by green sand, which caused a more rapid cooling of the exterior surface of the casting.

Seven hundred tons were passed through the core at the rate of four cubic feet a minute.

The charges used in the proof were as follows :—

Proof Charges.

8-inch,	1st fire—	12 lbs.	powder,	1 ball and sabôt, 1 wad.
„	2nd „	15	„	1 shell with sabôt.
10-inch,	1st „	20	„	1 ball and sabôt, 1 wad.
„	2nd „	24	„	1 shell with sabôt.

Service Charges.

8-inch, 10 lbs. powder, 1 ball with sabôt.

10-inch, 18 lbs. powder, 1 ball with sabôt.

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The number of fires made from each gun, including the proof charges, was as follows:—

8-inch	gun,	cast solid,	73 fires.
8	„	hollow	1500 „
10	„	solid	20 „
10	„	hollow	249 „

Each of them excepting the 8-inch gun cast hollow, burst at the last fire.

Two of the guns which burst, split through the breech and reinforce in nearly equal parts, leaving the chase with the muzzle in one piece almost entire.

On comparing the enlargement of the bores, made by an equal number of fires of the guns cast solid with those cast hollow, it will be seen in both pairs of guns, the enlargement is least in those cast hollow.

The tests taken from the sinking heads by numerous samples, and from various parts of the gun after bursting, showed that the iron used in all the guns was of very superior quality. The mean density of the samples was 7,290, and the mean tenacity 37,800, while the least tenacity was over 34,000. The qualities of iron contained in all guns may be regarded as essentially the same.

The following Table presents the results of all similar trials made at different periods:—

Date.	Description.	Quantity of iron.		Rounds fired.	
		Density.	Tenacity.	Cast solid.	Cast hollow.
1849	First pair 8-in.	7·223	27488	85	251
1851	Second... ...	7·287	37811	73	1500
...	Third ... 10-in.	7·292	37817	20	249
	Total	—	—	178	2000

It will be seen that the endurance of the guns cast hollow, greatly surpassed those cast solid in every case, where both were cast in pairs at the same time, and from the same material. This great difference therefore could not it is believed have been caused by any accidental circumstances, but from the care which was taken to ensure an exact uniformity in both guns of each pair, must be ascribed to the different methods by which the castings were cooled.

In the several pairs, cast solid and hollow, the actual strength of the *iron* in each gun of a pair, as measured by the testing machine, remained the same; while the strength of the *guns* in the same pair, as measured by the fires endured, differed greatly. From this it appears that the difference in the methods of cooling the casting, while greatly augmenting the strength of the *gun*, in one case, does not, in any, impair or affect the strength of the *iron*. For this and other apparently discordant or incongruous results,

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we must seek an explanation in the laws which govern the construction of iron when cooling.

It is stated (by Daniell) that the linear expansion of cast-iron between 62° and its melting point (2786·) is ·016389; equal to $\frac{1}{61}$ part of its length. It is known also, that the contraction under equal reductions of temperature is different in iron of different qualities. Soft, gray iron, that which contains a high proportion of carbon, contracting least; and that which founders term *high*, which is hard, light, and close-grained, and contains the least per centage of carbon, contracts the most, other circumstances being equal. The contraction of the same iron is greater, or less, according to the greater or less rapidity with which it is cooled. That which is cooled most rapidly, contracts most. Every experienced founder is aware of this, and endeavours so to proportion his patterns that all the parts of the same casting may cool equally. In the casting of heavy wheels for machinery, and for railroad cars, in which the hub is generally more massive than the spokes, or the rim, it is not unusual to see the founder remove the sand from the interior of the hub, and pour in water, to hasten the cooling of that part, and to force it to keep pace in cooling, with the spokes and rim. If this precaution be neglected, the spokes may break before the casting becomes cold, or they will be liable to break from a slight shock afterwards.

The cause of this may be explained as follows:—The rim and spokes being less massive, and cooling sooner, contract inward upon the hub, while the latter is yet liquid. The contraction thus far causes no strain, because the liquid iron of the hub presents no resistance to the spokes. But when the hub becomes solid, its temperature is at the melting point, while the temperature of the rim and spokes is much lower; consequently, a greater amount of contraction must hereafter occur in the former than in the latter. The hub in the effort to contract its diameter, after the rim and spokes have become cold, pulls the spokes inward, and as this movement is resisted by the rim, the latter is subjected to a force of compression, while the spokes are subjected to a strain of extension. And as the capacity of cast-iron to resist compression is six times greater than its capacity to resist extension, the spokes yield to the tensile strain, and are pulled asunder.

In the application of these laws of contraction to the casting and cooling of cannon, let us suppose that a solid cylinder, of indefinitely large diameter and height, be cast solid, and cooled in the usual manner. The iron when cast is at a temperature much higher than the melting point. It cools down until the exterior surface comes to the freezing point, when a thin cylinder is formed by congelation on the exterior, enclosing within it the liquid iron of higher temperature.

After the lapse of some definite period of time a second thin cylinder is formed within, and upon the first; and during this period, the first cylinder will have lost some portion of its heat, and its temperature will have fallen below the freezing point, and lower than the second cylinder. Next, a third cylinder is formed within the second, at which time the temperatures, of both the preceding, have fallen still lower, when there will be three cylinders, at three different temperatures. Let us suppose a continuance of this process of successive congelations, until all the liquid iron shall have become solid, and at the instant when this occurs, that the first or exterior cylinder shall have cooled down to the temperature of

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surrounding bodies. The difference of temperature between the exterior and the centre of the casting will then be about 2,700°.

In a casting thus formed by successive congelations, each layer forming at the freezing point, upon its predecessor of a lower temperature, it is supposed that when the last portion of the liquid iron became solid, it would be entirely free and unstrained by any contractions, but as at this time, the exterior of the casting has cooled down to a temperature at which contraction has ceased, and the interior remains just at the melting point, 2700° higher, the contraction due to the latter ($\frac{1}{61}$ part of its linear dimensions) is yet to occur in the centre, *after* the exterior has ceased to contract. The effect of such a contraction *must be*, to exert a strain of compression on the exterior, and one of elongation in the interior. The neutral line, on the part remaining unstrained by either compression or elongation, it is supposed would be, at about one-seventh of radius from the exterior surface. The extent of contraction in a 10-inch gun, cooled, as above supposed, with a maximum difference of temperature, would be about two inches in length, and half an inch in diameter, and, six-sevenths of the latter, would be in a direction from the centre towards the exterior, and tending to split open the gun.

The above supposes an extreme case, in which a maximum difference of temperature between the exterior and interior occurs—a condition which never exists in practice. But it serves, however, to explain the law which governs the contraction of iron, and what is believed to be its injurious effect in castings which are unequally cooled. There is no doubt of the fact, that cast-iron is injuriously strained more or less by unequal contractions when unequally cooled. What remains undetermined is the great measure of the consequences of such strains. The consequence in the extreme case supposed, would undoubtedly be to produce rupture in the interior of the casting; and in all heavy cannon cast solid a strain of this kind, of greater or less force, is believed to exist, and that it is exerted in a direction tending to assist the central force of the charge in bursting the gun. In the case of the 10-inch gun, cast solid, which burst at the twentieth fire (being of large diameter, and made of very high iron, both contributing to a large contraction), it is supposed that the strain thus produced was nearly sufficient of itself to split the gun, and that a few shocks only from the firing were needed to complete its destruction.

The greater the difference of temperature between parts of the same casting while cooling, the greater will be the strain. Therefore, in casting solid guns, the aim should be to retard the exterior cooling as much as practicable, in order to reduce the difference of temperature to a minimum. Heating the gun and the pit which contains it, as much as they will safely endure before casting, and continuing this heat until that of the casting falls to an equality with it, is suggested as the best method of accomplishing this purpose. It is believed, however, that such a slow cooling will materially affect the quality of the iron by reducing both its density and tenacity.

The contraction of *high*, hard and strong iron, is greater than that of soft, gray, and less tenacious iron, and consequently the injurious strain in the former is greater than in the latter. To the influence of this law and its consequences, we may in a great measure attribute the extraordinary results

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before mentioned respecting the two guns cast solid in 1851, compared with the similar guns cast in 1844. The former were made of the *high* iron, giving a mean test strength of 37,814 lbs. per square inch, and a mean endurance of 46 fires; the latter were made of the *lower* iron, giving a test strength of 26,367 lbs., and an endurance of 671 fires. From this it appears that a reduction of strain in the *casting* is of more practical value than an increased strength of the *iron;* and it follows that in order to diminish the strain of contraction in large guns cast solid, we should use the softer and less tenacious qualities of iron. If these conclusions are well founded, as they are believed to be, we must, in making large guns, cast solid, select a softer and weaker iron to commence with, and then impair its density and strength by a very slow process of cooling, in order to prevent the dangerous consequences of straining the iron by unequal contractions in cooling. This involves an abandonment of the harder and stronger iron, because of our ignorance in the art of managing it. These are conditions which should not be willingly submitted to. The obstacle in the way is the irresistable law of contraction under differences of temperature, and the remedy, it is believed, can be found only in conformity to that law.

The method devised for accelerating the cooling of the interior of guns by passing a stream of water through them, and for retarding at the same time the cooling of the exterior, by surrounding it with heated air, appears to lead in the right direction, and the facts established cannot be undervalued; and on a review of all the considerations herein presented it appears necessary that further trials should be made.

It is well known that the difficulty in making cannon, which shall be equally enduring and safe, with equally proportioned charges, increases as their calibres increase.

An explanation of the cause why the strain of contraction, in a large mass of iron, caused by unequal temperatures in cooling, affects so materially its power of resisting its central force (while it leaves unimpaired the strength of a small sample, detached from the same mass) may be added here to supply an omission elsewhere. Any material being under a strain of any extent within the limits of its elasticity, will on being relieved from the strain, restore itself to its orginal condition. The separation of the small sample from the large mass gives this relief to the former, which is then restored to its original condition, and to all the power of resisting strains due to its tenacity.

Report on the Effect of Time *in removing strains caused by the unequal cooling of Heavy Iron Castings. Dated, Pittsburg, U. S.,* October, 12, 1852.

The extreme proof of two 8-in. Columbiads, cast in 1846, was duly completed, with the following extraordinary results:—

		Density.	Tenacity.	No. of fires Endured.
Three 8-inch guns	1 cast and proved in 1851	7·287	37,811	72
	2 cast in 1846, and 3 proved in 1852	7·247	29,423	2582
		7·220	22,989	800

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The form, dimensions, weight, method of casting and cooling, and the manner of proving were the same in all. It will be seen that the gun made of the strongest iron, with a short interval of time between its manufacture and proof, endured the smallest number of fires; and that those made of weaker iron, but proved long after they were cast, endured the greatest number of fires. This remarkable feature in these trials suggests an inquiry as to the cause of such anomalous results.

The following Table exhibits an account of all the experiments made in casting guns solid and hollow, in pairs, and of the mechanical tests and the endurance of each in extreme proof; also of the extreme proof of other guns, of the same model not cast for experiment:—

Extreme proof and Endurance of Cannon.

Date of proof.	Cannon proved.	Interval between casting and boring.	Test of gun head samples.		No. of fires endured.				
					Service charges in guns cast.		Extra high charges in guns cast.		
			Density.	Tenacity.	Solid.	Hollow.	Solid.	Hollow.	
1849	8-in. Columbiads	..... 34 days ...	7·222	27569	84	—	—	—	
			7·233	27531	—	250	—	—	
1851	8-in. do.	..... 30 days ...	7·292	37961	72	—	—	—	
			7·287	37638	—	1500	—	—	not burst.
1851	10-in. do.	..... 48 days ...	7·273	40457	19	—	—	—	
			7·306	41952	—	248	—	—	
1852	32-pr. Cannon	.....110 days...	7·271	33590	1000	—	6	—	
			7·281	34307	—	1000	—	21	
	Mean of tests and total endurance		7·271	35126	1175	2998	6	21	
1844	8-in. Columbiad	...100 days	7·276	26367	731	—	—	—	
	10-in. do.	...100 days	—	—	600	—	12	—	
1852	8-in. do.	...6 years	7·247	29423	2582	—	—	—	not burst.
	8-in. do.	...6 years, 44 days	7.220	22989	800	—	—	—	

A new consideration appears to arise from these results; the longevity of strains which occur in the cooling of iron when cast in large masses, or the length of time during which a body will remain under a strain without a renewal of the straining force.

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It is assumed that any casting, or any other solid body will, if constantly strained for a long while, adapt itself in part at least, to its strained position; and lose its power of voluntary restoration to its original position.

Suppose for example, that a proof bar of cast-iron be strained in the testing machine, until its deflection is about two-thirds or three-fourths of that which it will endure without breaking, or until the deflection nearly reaches the point at which incipient molecular separation occurs, and that the pressure be then removed. It will be found that the bar has acquired a small measure of permanent set; but if the pressure is not removed, or if removed it be again applied and be continued a long time, it will be found that the bar has acquired a permanent set, nearly equal to its deflection, and that its power of restoring itself to its original position has been entirely lost. Its particles it would seem have adjusted themselves to their new and constrained positions, and become free or nearly so. It appears that they resist constraint, and contain the power of self-restoration for a short time only; but if the restraint be long continued, they gradually conform themselves to it, and become passive or acquiescent.

A bar which has been thus made to acquire a large permanent set, it is believed has lost a small portion of its power to endure renewed strains. It may be again pressed with a similar force, and acquire an additional deflection and permanent set, nearly or quite equal to that which had before been imparted to it. By repeating this process at long intervals of time, the permanent set of a bar may be extended, much beyond the deflection which it was capable of enduring when it was first strained.

Familiar examples of the facility with which bodies conform to constrained positions, may be observed in the hoops of common barrels, whether consisting of wood or of iron. The hoops when first bent around the barrel lose but a small part of their power of restoration; but when united at their ends, and driven firmly upon the barrel, they soon lose most of their active power of restoration; become passive and acquire a permanent set, conforming nearly to the circumference on which they were strained. When they have thus acquired this permanent set, they may be further bent upon smaller circles, until reduced to a curve which if attempted at first would have broken them, while the strength of the hoop will remain unimpaired. If solid bodies do thus relieve themselves from strains produced by the application of an external force, why may not a gun casting, relieve itself in like manner, from the strains caused by unequal cooling?

The strain produced in cannon in unequal cooling as described in the preceding reports, is one of compression on the exterior circumference, and of elongation on the circumference of the bore. It may be likened to the strain which would exist in a hollow cylinder, if the latter be cut through its thickness in one of its elements, and the fissure be afterwards enlarged by a mechanical force acting against the surfaces of the fissure. A strain thus produced would obviously stretch the interior surface of the cylinder, and compress its exterior surface. Now, if we suppose a strain of this kind to be so far extended, as to approach nearly to the point at which the incipient molecular separation occurs, any considerable addition of a central force, of any kind will evidently produce rupture. This is, it is believed, the condition of cannon when under a strain caused by unequal cooling. And as the

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force of fired gunpowder acts in the same direction, a few fires if made soon after casting the cannon, will be sufficient to burst it. But if the same cannon be allowed a sufficient time between the casting and proving, to free itself from strain, it will endure a number of fires proportioned to the tenacity of the metal from which it is made. What length of time may be required to free a gun from strain, can be ascertained only by experiment; but it will doubtless be found to be proportioned to the hardness and tenacity of the iron, and to the bulk of the guns. Hard strong iron contracts most, and consequently is most strained, but will require the longest time to relieve itself.

On this hypothesis the results obtained in the extreme proofs given in the preceding tables, may be rationally accounted for. If we refer to the 8-in. Columbiads, cast solid, we find that the one cast 1851, and proved in thirty days after it was cast, or in about three weeks after it had been cooled, with a tenacity of 37,811, endured only seventy-two fires; while of the two Columbiads of the same model cast in 1846, and proved in 1852, more than six years afterwards, one of them, with a tenacity of 22,989, endured 800 fires; and the other, with a tenacity of 29,423, endured 2,582 fires, and remains unbroken.

Results, so remarkable, cannot be accounted for in any other way than on the assumed hypothesis before mentioned, viz. that large iron castings, when cooled from the exterior, are unavoidably strained in cooling, and that such strains, if within the limits of incipient rupture, are removed by twice leaving the casting free.

The method of cooling from the interior tends to remove injurious strains in cooling, and if the method be sufficiently extended on this principle, a strain in the opposite direction may be produced. The strain in this case would be one of compression on the surface of the bore, and of elongation on the circumference of the gun; and the tendency of such a strain would be to prolong the endurance of the gun beyond the proportion of fires due to the tenacity of its metal.

Observations.

As the density of iron is increased, its liquidity when melted is diminished. This causes it to congeal quickly, and to form cavities in the interior of the casting. In the practical treatment of iron in fusion, while preparing it for casting it into cannon, we may safely continue it in fusion with increasing improvement of its quality, so long as sufficient liquidity is retained to ensure an exemption from cavities in the interior of the casting. The point at which such cavities of a fatal character will form, will be reached before the point of density for maximum tenacity is arrived at.

A convenient method for determining the condition of the iron while in fusion, and whether it has arrived at the proper condition for casting, or should be longer continued in fusion, is found in dipping from the melted pool of iron, and casting into small bars 10 inches long, 1½ inches square at one end, and tapering to a point at the other end. The first one is taken from the furnace, and cast soon after the iron is all melted, and others are cast at such intervals after as may be judged proper; they are cast vertically, point downwards, in green sand moulds,

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and cooled rapidly. They are then broken in different places, and the condition of the iron is judged by the appearance of the several fractures. These fractures will exhibit various aspects, from white at the small end, to dark gray at the large end; and the bars cast at the later periods of the fusion, will exhibit the white at a greater distance from the small end, and the mottle bright and lighter shades will be found advancing towards the large end. This method, although much less reliable, than that of an actual measure of density and strength, is convenient because of its ready application, at short intervals, while the iron is in fusion; and a practised eye will soon be able to make the progress of the changing quality of the iron, and to determine the proper time for casting the gun.

After the completion of the castings and tests in March, 1851, four large Columbiads, were cast in July and August of the same year. These were two 8-in. and two 10-in. Columbiads made for the purpose of an extreme proof with powder and balls. They were made from the same qualities of iron, and although made at a foundry 500 miles distant, and by founders not before acquainted with the qualities of the particular iron used, or with its proper treatment, yet by following the laws which had been developed in former trials, the same and even better results were obtained.

The tests from the samples taken from these four Columbiads, which are extracted from the report of the trial of them, dated January 24, 1852, are as follows:—

Fort Pitt Foundry, U. S. 1851.

Cannon Tested	Mark of Samples.	Density.	Tenacity.
Two 8-inch Columbiads	3. H. 0	7·289	36891
	3. H. 1	7.295	39031
	3. H. 0	7·281	43650
	4. H. 1	7·290	36090
Two 10-inch Columbiads	5. H. 0	7·273	40457
	6. H. 0	7·296	40997
	6. H. 1	7·306	42425
	Mean	7·290	39934
Four 32-pr. guns, the last cast at West Point	Mean	7·260	38093

These results, obtained at different foundries show what may be accomplished anywhere, with good materials skilfully treated, according to laws now known and established.

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Remarks on a new pattern Limber and Ammunition Wagon, with observations on different Systems of draught. By Captain LESLIE, R.A.

I HAVE long thought that many improvements might be effected in the carriages of our field artillery, and that means might be adopted for carrying our gunners into action on their guns, better arrangements made in the packing, and carriage of our ammunition, and stores; also, that our harness might be simplified, and lightened, and our horses placed in draught in a more advantageous manner.

The following suggestions will not, I hope, be thought out of place at the present time, when everything connected with artillery is assuming such importance, and every day developes some wonderful power belonging to it, hitherto lying hid, or only very imperfectly known.

The remarks I am about to make are entirely of a practical character, written principally to explain the alterations I would make in our carriages, &c. and the reasons for so doing; and descriptive of an ammunition wagon I have had altered according to my views.

I have endeavoured to be as explicit as possible, perhaps too much so. I hope, however, faults will be overlooked, and that if my suggestions have no better result, they will at least induce other officers of the regiment, and particularly of the field artillery, to turn their minds to practical improvements in everything connected with their particular branch of the service. In the alterations I have made, I have restricted myself to the carriages, &c. of a 9-pr. battery, but they are equally applicable to those of others.

I wish to remark, that, in proposing to carry enough men on the limber of the gun to work it in action, I disclaim all idea of altering, or interfering with our present horse artillery system. Although but a very short time in that branch of the service, I saw quite enough of it to convince me, that field batteries can never take its place, or do its duty at all effectively; and I believe, prejudice or disappointment has a good deal to do in influencing many of those who hold an opposite opinion. No doubt I should wish to see the horse artillery and field batteries assimilated in many points (to the advantage of the latter), but that might be done without any bickerings or jealousies; there is a sufficiently wide and noble field for each, without interfering with one another.

There are, of course, many difficulties to contend with, in introducing my new pattern wagon, &c. The present one has been but little modified, for I believe, forty or fifty years, and it is perhaps a natural idea, that what has gone on so long without change, and done so well, must be pretty good. Men are more or less opposed to innovations in anything, and the principle is, no doubt right; however, I only ask, that my proposed alterations may not be condemned without being well tested on their own merits.

I will now state the advantages I propose to obtain, with a few remarks on each.

ADVANTAGES.

(1) A sufficient number of men carried into action with each gun, to work it until others can come up from the wagon.

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(2) An improved ammunition box, and method of packing the ammunition.

(3) Making all the ammunition boxes in a battery of the same size, and with similar fittings.

(4) An increased number of rounds carried in each limber and subdivision.

(5) A different way of carrying the spare wheel, allowing it to be more easily and quickly taken off to replace a disabled one, and by which it is more out of the way than at present.

(6) An increased number of men carried in a subdivision, and a better place for their knapsacks.

(7) The weight brought nearer to the horses in the wagons.

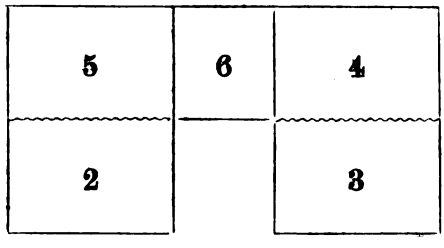
(8) A different mode of draught, giving more power to the horses, with many improvements in the harness.

(9) A different way of carrying the camp equipage.

ADVANTAGE 1.—Being able to carry a sufficient number of men with the gun to work it in action, until those with the wagon can come up.

I think every one will at once allow that this is much to be desired, and I propose to do it as follows:—I make my ammunition boxes about six inches longer, from front to rear, than the present limber boxes, and place them rather wider apart. The space between, I fill up flush with two smaller boxes (for spare shoes, grease, &c.), but which are only about half the length of the large boxes (not extending in rear of the bed). The ammunition boxes are nearly balanced on the axletree bed, and when the whole of the numbers are mounted, there will only be a few pounds weight on the poles. I carry three men abreast facing the horses, and two men facing the rear, making five men on the gun limber (the same on the wagon limber). These numbers I propose telling off in the following manner:—

Top plan of Boxes.



Rear.

Nos. 2 and 3 will drop down instantly the word "*halt*" is given, by a very simple arrangement, 2 can free his sponge, without the aid of the present No. 4, thereby doing away with the awkward throwing over of it, which is at present necessary. No. 5 will assist No. 1 to unlimber, 3 and 4 manning the wheels, 3 going to his present place immediately it is done, 4 doing the duty of the present Nos. 4 and 5, and now, that nothing but friction tubes

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is used, one man can very well do both duties, viz. serving the vent, priming and firing, and indeed, I think, there would be less confusion and liability to accidents, by his so doing.

No. 5 would do the duty of the present No. 6, and No. 6 that of the present No. 7, and go at once to the rear with the limber.* I propose that No. 1 should be mounted, so as to have the entire charge of his gun at all times, and a better control over his subdivision, and that he should give all words of command. At present the No. 1 is carried on the limber, and gives some words of command, and there is the mounted non-commissioned officer who gives others. I also propose that besides the six mounted non-commissioned officers, or Nos. 1, there should be three markers mounted, one for each division, who would hold the horses of the two Nos. 1 belonging to his division (when in action), and also take up points for it, and thus always leave the Nos. 1 to have the charge of, and direct their subdivisions, which cannot be done at present by the mounted non-commissioned officer, as he has frequently to go out as a marker, leaving no proper person to give the words of command, thereby causing much confusion, and many mistakes in drill. The Nos. 1 should ride between the guns of their respective divisions, viz. on the left of 1, 3, and 5 guns; on the right of 2, 4, and 6 guns, except when the line was reversed, when the odd Nos. 1 would be on the right of their guns, and the even Nos. 1 on the left. The marker to ride between or just in rear of his two Nos. 1, so as to be able to take their horses, immediately on coming into action.

There would never be any difficulty in bringing six men up with the gun; as I propose, an ample number for all drill purposes, and sufficient to work it in action until the other numbers came up from the wagon. I believe six is the number required to work Sir W. Armstrong's field battery gun. The detachment being carried in this way, would put an end to that absurd and erroneous system (still carried on in the field batteries) of drilling with the wagons; simplifying the drill to a great degree, and easing our at present over-worked wagon horses, which (although always inferior in every way to the gun horses, and fewer in number in each carriage) have actually when a battery is in heavy marching order, and the gunners mounted, to pull a greater weight than the gun horses, and keep up the same pace. Any one looking at our batteries moving at present, may observe, that while our gun horses are going freely along, our wagon horses have to strain, and over exert themselves to keep up. Taking a common sense view of the matter, as at present, an officer commanding a battery ought to put his best horses into his wagons, and his inferior ones into his guns; but I am afraid little would be thought of the officer commanding, or of the appearance of a battery, the teams of which were told off in this manner. The system of drilling with the wagons, could not of course be carried on under fire, and I believe those officers, who were present at the Alma, can testify to the

* Two men are quite enough to lift the trail; a third man has very little power, and is in the way. One man is also quite enough to man each wheel, as he can put his whole weight to it, and get a proper purchase, which two men cannot. Moreover, I work my men without knapsacks; and, as I have had said to me by old and intelligent non-commissioned officers and men, "One man *without* his knapsack is better than two with them on."

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difficulty there was in bringing our guns into action, from the simple reason, that we could not bring our gunners up as quickly as the guns; and such would doubtless be always more or less the case, in making a rapid attack on such a position as the Russians held at that battle; if it is so, surely some means should be adopted to bring the gunners up along with their guns, at whatever pace the latter may be brought into action.

It has been proposed to follow the Bengal Horse Artillery system, and mount men on the off horses, but I think there are many objections to this. In the first place, the men would, or ought to be gunners, and therefore heavy men,—not good horsemen, loading and distressing the horses, and in all probability, incommoding the proper drivers, and preventing them getting their guns on as they otherwise would (particularly in difficult or heavy ground). Moreover, each horse would have to carry a man's kit, an addition of some 25 lbs. At present our off horses carry the drivers kits, easing their riding horses of so much weight.

Those officers who are in favor of the old gunner and driver system, and I believe there are still a few, will say, that the men on the off horses ought to be as good horsemen as the drivers; granting this, which might easily be the case, as not one man in twenty under the old system had the faintest idea of sitting a horse properly, it is no answer to the great weight thrown on the off horses. I now often look with wonder at the immense gunners, who a year or two ago were drivers, splendid men in their proper place working a gun, but the last men in the world to be put on horses as drivers.

I am also informed that the Bengal Horse Artillery work in the most straggling manner, their horses pulling unevenly, and jerking at their work, and such I can well fancy to be the case with gunners mounted on the off horses. Besides all this, it is very much easier for a horse to draw the additional weight of a man, on the limber, than to carry it on his back. I think Captain Milward's plan of carrying a saddle as a pad, very good, as it answers all the purposes (although certainly heavier); and it would be very advantageous having more saddles in a battery, than the present complement (especially for drill purposes). Should his plan be adopted with the view of carrying men, I would suggest the kits being placed in rear of the saddle, fixed as they are at present, they would have to be removed and fastened on elsewhere, before the men could mount, which would, of course, occasion much delay.

An objection may perhaps be made, to my ammunition boxes projecting over in rear of the axletree bed, as being in the way of limbering up, but the French box does quite as much, and comes right over the limber hook, whereas I leave a clear space of 10½ inches there, between the boxes; and I think, with ordinary care, and having the boxes plated, no injury to them would ever occur. The hurry scurry of limbering up in drill, is mere show, and surely if the French gunners can limber up with their boxes, ours can do so much easier with those that I propose.

ADVANTAGE No. 2.—An improved ammunition box, and better mode of packing the ammunition.

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It is very awkward to get the ammunition out of the present box, made as it is, with the top to open; a man has to reach over, put his arms down, and to unbutton and lift up lids to get at the lower tier; the shot, &c., have all to be lifted out; and I doubt very much, if a man standing on the ground, could get them out at all,—certainly not the lower tier; a short man has difficulty, in getting at the inside of the boxes at all, unless he mounts on the carriage; from the mode of packing, it is difficult to know, or recollect, where each kind of shot is, and there is no convenient place for preparing shells, &c. The cartouche is not so well protected as it might be, and is difficult to open or get out. There is difficulty in getting at the different implements, small stores, &c., as they are put in without any order or arrangement.

To obviate these disadvantages, I have the top of the box a fixture, making one end to open instead; when the box is on the limber, the opening will be to the rear,—when on the wagon body, to the front. The shot, shell, &c. I pack in trays to pull out, and so as not to shake or shift in the least; four 24-pr. shot, and five 9-pr. shot in each tray. The case I put in trays by themselves, and the implements, &c. are on trays also, above the ammunition, and are got at instantly. As the trays in a subdivision are all of the same size, great facility would be given in filling the limber boxes when empty, from the body boxes, as the loaded trays would only have to be taken from them to the limber boxes, and replaced by the empty ones. The cartouche is in a centre partition, with shot on each side of it, which gives greater security to the powder than it has in our present mode of packing. A man standing on the ground, no matter how short, can easily pull out the trays and get at the ammunition (they might have painted on their ends the kind of shot they carry). The door when open, makes a very convenient place on which to prepare shells, &c. &c.; a fixed key can be screwed on to it, for unscrewing the metal plugs, and placed so as to be quite out of the way. The cartouche is much easier got out than in our present boxes, having only to be drawn out instead of lifted. Less rain would get into the box (having the end to open instead of the top) when ammunition was being served out. The ends of the boxes would, of course, have to be made water-tight, in case of fording, but this might easily be done by making the door to project inside the box, and shut against buff leather, or vulcanized India rubber.* The painted cartouche would keep the cartridges dry, even should a little water get in. A gutta-percha cartouche has been suggested to me, which I have no doubt would answer very well if not too expensive. I have had some wooden cartouches made, which I think will give great protection to the powder, and as the lid is made to slide, they can be opened and shut instantly; by painting them well inside, they can be made almost perfectly water-tight.

The centre compartment where the cartouche is can be rendered water-tight in itself, by cushioning the part of the door which shuts against it, as I have done in two of my boxes; and if that compartment is water-tight, it is not of so much consequence about the outside ones.

It has been objected to in my box, that should the door be open,

* My wheelers had not the proper tools for fitting the doors in this manner.

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and the horses in the limber start off, before the man (serving out the ammunition) could shut it, the trays would slide out; this can easily be prevented, by a small pin going through each tray, into an eye fastened into the batten below, as now fixed in my boxes. I must say, however, that I think the objection quite frivolous, and experienced field artillery officers agree with me. Is it likely that two, three, or four drivers would allow their horses to go off with them just as they liked? I have been eight years attached to field artillery, and I never even heard of such an occurrence taking place; and it would be quite as likely, or more so, to happen at drill with horses fresh and in good condition, than on actual service, when hard worked, and in all probability, badly fed. I think it would not matter much what became of the ammunition of a battery; the drivers of which could not control their horses until the ammunition boxes were shut.

Another objection that has been made is, that there would be a great send of the trays against the door of my box; this would be the case, if they were much shorter than the box, but as there need be little or no play in the trays, I deny that the send objected to would take place; but even allowing that such would be the case, the small pins already spoken of would quite prevent it.

Advantage No. 3.—Making all the ammunition boxes in a battery the same size.

At present our limber boxes are totally different from those on the wagon body, both in size and interior fitting, and carry much less ammunition. I propose making all the boxes the same size, and similar in every respect, carrying the same number of rounds in the limber as in the wagon body boxes (the interior fittings of the 24-pr. and 9-pr. boxes are of course different, in size, but similar). The same box, therefore, with its cartouche, fittings, &c., does for the wagon body and limber. The off box on the body, becoming the near box on the limber, and *vice versâ*. The advantages of this arrangement are so obvious, I need say nothing more. The French boxes are all alike, but I think very unwieldy from their being so large.

The following are the dimensions of the present limber and wagon body boxes, and of my proposed boxes:—

Present Limber Box.

	feet.	inches.
Breadth	1	8¾
Length	1	7¼
Depth	1	6

Wagon Body Box.

	feet.	inches.
Breadth	2	4½
Length	1	8½
Depth	1	8½

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Proposed Box.

	feet.	inches.
Breadth	1	7¾
Length	2	0¾
Depth	1	6¾

By packing the small stores differently, the height of my box might be reduced.

I attach my boxes to the carriage without either straps (which can never be got exactly the right length) or lashings (which take a long time to fasten or unfasten, soon rot, and are clumsy looking); instead of these, I have an iron band rivetted on the bottom of the box, with a socket in the centre of it, into which an iron bolt or tongue fastened on the carriage, slides. The iron tongue is screwed on to the axletree bed of the limbers, and to the perch and side pieces of the body. The socket is near the end of the box which opens. The iron band gives great additional strength to the boxes. The other end of the box, I fasten as at present with a bolt and pin; by taking this pin out, the box can at once be drawn off the carriage. Boxes attached in this manner can be taken off or put on, much more quickly than when straps or lashings are used.

Advantage No. 4.—An increased number of rounds carried in each limber and subdivision. In a 9-pr. battery, at present there are carried in a subdivision 128 rounds for the guns, 84 rounds for the howitzers. By adopting my pattern boxes, there would be carried in a subdivision, 144 rounds for the guns, 90 rounds for the howitzers; being an increase per subdivision, of 16 rounds for the guns, and 6 rounds for the howitzers. In the gun limbers at present are carried 32 rounds, in the howitzer limbers 24 rounds; with my new boxes, there are carried in each gun limber 48 rounds, in each howitzer limber 30 rounds. There being the same increase in the number of rounds, in each limber, as in the whole subdivision; the diminution in the number of rounds, being in the wagon body boxes, they at present, for the guns and howitzers respectively, carrying 64 and 36 rounds; while in my wagon boxes, would be carried only 48 and 30 rounds respectively; my carrying an increased number of rounds in the limbers, makes the guns much more independent of their wagons, than at present; and as I propose carrying a sufficient number of men, to work the gun in action, without the aid of those mounted on the wagon, it is, I think, a great advantage.

Advantage No. 5.—A different way of carrying the spare wheel, allowing it to be more easily and quickly taken to replace a disabled one, and by which it is more out of the way that at present. Should the spare wheel be wanted, as now fixed, the wagon body must be unlimbered, and I very much doubt, if two men could take the wheel off; it would certainly require three, to do so at all quickly, as the perch and drag has to be passed through the spokes of it; at drill four or five numbers are allowed. The wheel in its present position, is also very much in way of the front ammunition box on the body; in fact, it is impossible to get

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anything out of it without a man mounting up on the foot board; it is also greatly in the way of the men mounting and dismounting on the wagon body.

As I propose to carry the spare wheel, viz. in rear of the platform where I put the knapsacks, resting on the perch (prolonged for the purpose), it is quite out of the way of the ammunition boxes, or of men mounting or dismounting; as I have no rear boxes on the wagon, as at present, two men can instantly lift it off with the greatest ease, and even one man without much difficulty; it is secured even more firmly, than where it is now placed, as the side pieces of the wagon body stay it under the ends of the spokes.

ADVANTAGE No. 6.—An increased number of men carried in a subdivision with a place for their knapsacks.

At present ten men are the most that can be carried on a gun and wagon (and that can only be done by mounting three men on each limber, which is not intended); and there are places for only eight knapsacks. On my gun and wagon, I carry twelve men, five on each limber, and two on the wagon body. When the tents are on the wagons, it is only with great difficulty that the knapsacks can be put on the wagon bodies at all. It may be said, it is no advantage being able to carry more men than at present on the gun and wagon; but I think in many instances, such as making a forced march, with perhaps only a portion of the battery, it would be a very great advantage. Again, many say, and indeed the regulation now is, that gunners should carry their knapsacks. In answer to this, I would urge, that if there are any soldiers in the service who should have their knapsacks carried for them, and be perfectly unincumbered, they are gunners. They may have to assist in getting their guns up and down difficult places; through heavy, sandy, or swampy, ground; to level, fill up, or cut down obstacles; to replace disabled wheels, shafts &c.; to dismount, and carry off as they best can, guns, and disabled carriages; to take out or put in a draught horse in a hurry, with most likely, horses kicking and plunging all round them; and I will leave it to any unprejudiced person to say, whether these duties would be likely to be better done by men encumbered with a heavy knapsack, or by others quite free. After a long march, or perhaps at a moment's notice, on the line of march, they may have to come into action, and fight their guns for hours. Will not gunners without their knapsacks, be more fresh and better able to maintain a combat, than if they carried them? A knapsack on a man cramps him in every way, and is a very great load to carry any distance; whereas, to the horses in the wagon, there would be no perceptible difference, whether the twelve knapsacks were on it or not. The total weight to some six horses being perhaps 2½ cwt., not ½ cwt. per horse, and this weight be it recollected only to draw, not to be carried, as in the case of a man, with his knapsack. Twenty-five or twenty-six pounds is a good weight for a man to carry for any time, particularly, when it is fastened on to him, in a manner, which confines his chest, arms, and entire action, and so that he cannot ease himself by shifting it, as in any ordinary load.

There can be no doubt, that if every man in an army could have his knapsack carried for him it would be so much the better, but with infantry,

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of course this is almost impossible* The cavalry soldier has his kit carried for him by his horse, and yet a gunner is not allowed to have his drawn for him by his horses. Why not (arguing in the same way) make the cavalry soldier have his knapsack strapped on his own back, instead of his horse's? He does not require more freedom of movement, than a gunner; moreover, a horse with his rider's kit on, is more likely to be destroyed than a wagon, and the kit consequently lost; so even with regard to the security of it, there is more reason for a cavalry soldier to carry it than for a gunner. Take again the case of a man being badly wounded, with his knapsack on; it would in the hurry most likely be thrown aside and never seen again, and the unfortunate man left without any of his necessaries at the very time he most required them; whereas, if it were on the wagon, it would in all probability be safe, and the man in time have the benefit of its contents.

Lately, Nos. 1 and 6 have been allowed to have their knapsacks strapped on the gun limber, and to be carried on it themselves; if that is right, surely it must be right that all the numbers should have the same advantages. The only reason I can see against it, is, that of course, on service, our wagons could not come up under fire, therefore the men could not be carried on them into action; but that is no reason why the knapsacks should not be carried on them, if it can be done. I propose therefore to carry the twelve knapsacks of the men on the wagon body, they would there be comparatively safe, more so than on the mens' backs. The only two now allowed to be carried (belonging to Nos. 1 and 6) are placed on the most exposed place in the subdivision, viz. the gun limber, on it I would carry nothing I could help; certainly nothing so essential to a man's comfort as his knapsack. Where I place the knapsacks in rear of the wagon body boxes, is out of the way of everything—ammunition boxes, tents, spare wheel, &c. They can very easily be put on or taken off, and a water-proof cover could easily be strapped over them all, so that the mens' kits would be kept perfectly dry in wet weather, even should the knapsacks not be in very good condition.

ADVANTAGE No. 7.—The weight brought nearer to the horses than in our present wagons.

By taking the spare wheel from its present inconvenient position, I am enabled to shorten the perch 8-inches, bringing the body and limber wheels so much nearer together; this, as every one knows, will lighten the draught of itself, and the wagon body with its load will, of course, be that much nearer the horses. As shown under advantage No. 4, the increase in weight in the ammunition of a subdivision, is thrown entirely on the limbers, consequently, nearer to the horses, the decrease in weight being made in the body boxes, further from the horses.

I need scarcely say, that, it is easier for horses to draw a heavy weight

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* It appears by the accounts of the recent campaign in Italy, that the French troops had (to a great extent) their knapsacks carried for them, and that the Austrian troops when engaged found their's so much in their way that they threw them away by thousands, and so apparent was the advantage to the men of not carrying their knapsacks, that the Emperor of Austria was induced to give orders for his troops to have their's carried for them also.

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on the limber close to them, than on the wagon body a long way off, particularly as it is attached, by the limber hook and trail eye, &c.—not as if they were one fixed carriage. Any serious increase of weight on the body of the wagon is therefore very objectionable.

A simple illustration of this adjustment of the weights may be made as follows.—Suppose there were two carts, one empty, and one loaded, and only one horse to draw the two, into which should the horse be put, and which fastened behind the other? of course the horse ought to be put into the loaded cart, and the empty one fastened to it; no one, who knew anything of the matter, would put the horse into the empty cart. So it is with our limber and wagon, if weight is taken from the wagon body, and put on the limber, it makes the pull easier for the horses.

By looking at the following Tables, the weights on the limber and wagon bodies respectively, in the old and new systems, will be easily seen, shewing that as I propose, the weight on the wagon bodies is reduced, although not quite to the same amount, as it is increased, on the limbers, thereby lessening the weight on the part of the carriage further from the horses, although increasing it on that part nearer to them.

Table shewing the principal weights carried on the present Limbers and Wagon bodies, and on those proposed by me.

9-pr. GUN.

		cwt.		cwt.
Old limber	32 shot	2½	.....	8½
	32 cartridges	¾		
	3 men	4½		
	3 knapsacks	¾	without men...	4
New limber	48 shot	4	.....	12½
	48 cartridges	1		
	5 men	7½	without men...	5
Old wagon body	64 shot	5	.....	13½
	64 cartridges	1½		
	4 men	6		
	4 knapsacks	1	without men...	7½
New wagon	48 shot	4	.....	11
	48 cartridges	1		
	2 men	3		
	12 knapsacks	3	without men...	8

24-pr. HOWITZER.

Old limber	24 shot	5	.....	10¾
	24 cartridges	½		
	3 men	4½		
	3 knapsacks	¾	without men...	6¼
New limber	30 shot	6½	.....	14¾
	30 cartridges	¾		
	5 men	7½	without men...	7¼

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Old wagon body	36 shot ..... 7½ 36 cartridges ... ¾ 4 men ..... 6 4 knapsacks ... 1	.....	15¼
		without men...	9¼
New wagon body	30 shot ..... 6½ 30 cartridges ... ¾ 2 men ..... 3 12 knapsacks ... 3	.....	13¼
		without men...	10¼

By these tables it will be seen that, by the present arrangement of the weights, there is when the men are mounted, 2¼ cwt. more weight on the 9-pr. wagon body than on mine, and 1 cwt. more weight on the present 9-pr. wagon body than on my 9-pr. limber. So there is much more friction on the body wheels in the present wagon than in mine, and more also than there is on my limber wheels; and this, the greatest amount of friction on any of the wheels, is a point of great consideration. There is nearly the same amount of weight in favor of my 24-pr. limber and wagon, over the present one.

9-pr. Gun.

Vertical Sections.

Near Limber Box.

Tools, &c. &c.	Tools, &c.	Tools, &c. &c.
2 Case.	Cartouche.	2 Case.
5 Shot.		5 Shot.
5 Shot.		5 Shrapnel.

Off Limber Box.

Tools, &c. &c.	Tools, &c.	Tools, &c. &c.
2 Case.	Cartouche.	2 Case.
5 Shot.		5 Shot.
5 Shot.		5 Shrapnel.

Near Body Box.

Tools, &c. &c.	Tools, &c.	Tools, &c. &c.
2 Case.	Cartouche.	2 Case.
5 Shot.		5 Shot.
5 Shot.		3 Shot. 2 Shrapnel.

Off Body Box.

Tools, &c. &c.	Tools, &c.	Tools, &c. &c.
2 Case.	Cartouche.	2 Case.
5 Shot.		5 Shot.
5 Shot.		3 Shot. 2 Shrapnel.

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Old limbers.		New limbers.
6	Shrapnel	10
18	Shot	30
8	Case	8
32		48
2		2
64	In two limbers	96

Old body.		New body.
8	Shrapnel	4
56	Shot	36
0	Case	8
64		48
64		96
128	Old gun and wagon } Total { New gun and wagon	144

Old gun and wagon.		New gun and wagon.
20	Shrapnel	24
92	Shot	96
16	Case	24
128		144

24-pr. Howitzer.

Vertical Sections.

Near Limber Box.

Tools, &c. &c.	Tools, &c.	Tools, &c. &c.
4 Shell.	Cartouche.	2 Case. 1 Shrapnel.
4 Shell.		4 Shrapnel.

Off Limber Box.

Tools, &c. &c.	Tools, &c.	Tools, &c. &c.
2 Case. 1 Shell.	Cartouche.	4 Shrapnel.
4 Shell.		4 Shrapnel.

Near Body Box.

Tools, &c. &c.	Tools, &c.	Tools, &c. &c.
2 Carcasses. 1 Shell.	Cartouche.	4 Shrapnel.
4 Shell.		4 Shrapnel.

Off Body Box.

Tools, &c. &c.	Tools, &c.	Tools, &c. &c.
4 Shell.	Cartouche.	3 Shrapnel.
4 Shell.		4 Shrapnel.

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Old limber.		New limber.
12	Shrapnel	13
8	C. Shell	13
4	Case	4
24		30
2		2
48	In two limbers	60

Old body.		New body.
18	Shrapnel	15
16	C. Shell	13
2	Carcasses	2
36		30
48		60
84	Old gun and wagon — Total — New gun and wagon	90

Old gun and wagon.		New gun and wagon.
42	Shrapnel	41
32	C. Shell	39
8	Case	8
2	Carcasses	2
84		90

An objection, may perhaps, be made to the additional weight I am throwing on the gun horses, but I will endeavour to answer this. The extra weight I throw on them, is about 3 cwt. for the two additional men, and say 1 cwt. for ammunition; the actual weight of the latter is rather more, but I take away two mens' knapsacks, or about four stone. I thus only give about four cwt. additional for them to draw, or ½ cwt. each; not a very serious increase in weight, more particularly as it is entirely on the limber, close to them, not, as if it were on the gun carriage. As I have said before, our wagon horses are terribly overloaded in proportion to our gun horses; this for purposes of parade, or drill, may not so much signify, but never would do on actual service, in a long campaign. I would more equalize the weights on them. The slight additional weight I put on the gun limbers would tend to do this, as the number of rounds in my wagons, both gun and howitzer, is the same as the present ones carry, while a great part of the weight is moved from the body to the limber, and as I also move two men from the body to the limber, and the wagon and limber wheels are eight inches nearer together than at present, I think I give the wagon horses less to do; the guns would also be more independent of their wagons, than they now are, which would most likely be a saving of work to the wagon horses, as the wagons would not have to keep in such close attendance, I might take the two men off the wagon body, and still carry as many on the carriages of a subdivision as at present. This would make the weight on the wagon body about 3 cwt. less than what I have put down, and about 1 cwt. less than is carried on our wagons at present.

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ADVANTAGE No. 8.—A different mode of draught, giving more power to the horses, with many improvements in the harness.

Our present mode of placing the horses in draught is two and two, the number in a team for a 9-pr. gun, or 24-pr. howitzer on service being eight We place our off wheelers in shafts, and this, the shaft system, is in great favor with us; but, I believe, we are the only European nation that adopts it, and that alone, I think, shows there must be disadvantages attending it, and such I fancy to be the case. In the first place, it has always struck me, that our shaft horse is worked to death, and the number that soon knock up proves this. In pulling up short, nearly the whole weight of the carriage is thrown on him, the riding horse doing comparatively little; he has also nearly all the work to do in wheeling and reversing; and I believe one great reason, Continental nations do not use the shafts is, that they cannot get horses powerful enough to put in them. Again, a great defect in the shaft system, is the way the outside shaft is attached, viz. to the end of the axle-tree arm, passing close along the outside of the wheel. In going through sticky ground, the wheel in revolving turns up the mud (just as a potter's lathe), and it is jammed against the shaft, until it becomes a solid mass, or wheel of clay. This disadvantage was complained of in the Crimea, and I was shown a drawing by one of our officers, made by him, of a wheel in this state. The draught on the horses when the wheel gets in this condition, is of course, enormous. As, I believe, this is the only secure way the outside shafts can be fixed, this disadvantage will always remain. The off-shaft being fastened in this manner, also causes a delay in replacing the off fore-wheel in case of its being disabled. Another disadvantage in our shafts, is their being cut out more or less across the grain of the wood, whereas poles are cut out quite straight with it, and can therefore be made lighter with equal strength.

The advantages supposed to be gained by shafts,—are greater quickness in stopping and turning, and, I believe, they do possess these over the one pole, as well as being stronger; but I think that the increased quickness in manœuvring is of little moment, it may be very well to show off at a review, but on actual service, the being able to stop or wheel on a few inches of ground, more or less, can be of no consequence, certainly not compared with the saving of wear and tear in horses. However that may be, all the advantages of power possessed by the shafts I think I obtain in my proposed system, viz. of having two poles and three wheelers, and I gain many not possessed by shafts. In the first place, they are stronger and lighter; again, with two poles and three wheelers, the power of backing is enormous (much greater than can be obtained under our present system), as any one who has seen the immense omnibusses in some of our large provincial towns, must have remarked, and that with the pole chains attached to the hames, which is not nearly so good as the French system of bringing the breeching right round to the chest, and which I would adopt. I think even in wheeling, the two poles would be found to give as much quickness as the shafts. Again, having a third horse close to the gun is, of course, an immense increase of power in the draught; and I am convinced that the three wheelers (as I propose) would pull as much as our two wheelers, and two leaders in a team of eight do at present; in fact, that seven horses in my plan of draught would do as much or more work than eight do in the present.

I would mount a driver on each of the outside wheelers, and make the

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centre horse carry both their kits, strapped parallel to each other along the horse's back, not across, as the valise is now (I have had a pad made for the purpose).* As I have scarcely any weight on the poles in my new limber, the centre horse would carry very little, if any, more weight than the shaft horse does now. The leaders I would put on, I think, two and two, to save drivers, and the centre pair I would attach by swingle trees to the ends of the poles, in order to get the pull direct on the carriage, and to give a better angle for their traces than starting from the shoulders of the wheelers, as the points of the poles would be lower. If it was objected putting the two leaders on in this way, three leaders might be attached to the horses behind them in the usual way, and drivers in the same way as the wheelers, or, if possible, by one driver on the centre horse. If this was found to answer, there would only be three drivers for six horses, and the off leaders could carry the kit belonging to the off wheel driver, and so only give the centre wheeler one man's kit to carry. I am convinced one driver never could drive the three wheelers from the near horse, as he has no power whatever over the off horse. The wheelers I would attach to the carriage by swingle trees, for two reasons—(1) to shorten the splinter bars; and (2) to give greater facility in hooking and unhooking, as one hook on the swingle tree would either fasten them or free them, instead of having to unhook both traces. This same advantage applies of course to the centre leaders, if attached by swingle trees. One of the greatest defects in the one pole system of draught appears to me having to suspend the pole from the collar, as the weight (although in the French carriages very little) comes on the withers, too far forward on the horse. By having two poles, I can suspend them over the centre horse's back, thus throwing the weight on the proper part of the horse.

Instead of our present tugs, I have two thin irons (covered with leather) attached to the buckles of the back band, they are open at the top, and there is therefore no necessity of the points of the poles being run in first, as with tugs, and which with restive horses is a troublesome business. A small strap buckled over the pole, across the opening, keeps all secure; and on being unbuckled, at once allows the poles to be lifted out, and cleared from the horse, much more quickly than can be done with the tugs, particularly when the horse is on the ground, as in the case of accidents. The back band passing under the buckles, serves as the belly band,—and, as I have scarcely any weight on my poles, the back band, &c. can be made much lighter than our present ones.

The irons, I propose, could be used with our present shafts.

All artillery officers must know the trouble and time it takes to get a horse that has fallen, or been disabled, out of a carriage, chiefly from the difficulty there is in unhooking the traces; the present clumsy trace-hook being impossible to unhook, when the horse's weight is on the trace. Many

* This pad is very unsightly, and might be much improved on. I may say the same with respect to much of the work in my wagon; but one cannot, of course, expect to get things quite right at first. Had I another carriage to fit, there are many little improvements I could make in it over the present one.

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hooks have been proposed to obviate this difficulty, but I believe none have been approved of. Some are too complicated and expensive, others not found to answer under all circumstances. The hook, I propose, is I believe quite different from any yet submitted, and is I think, simple and inexpensive to make, cannot get out of order, and should it get broken, could be mended quite as easily as our present hook. I have had some on trial for months; I had them on, when the wagons were trotted the 500 miles (to test the gun metal plugs in the shell), on the march to Brighton and back, and to Chichester and back, and at all drills, &c., for the last four or five months, and I have found them answer perfectly. The trace can be freed immediately no matter what weight is on it, and no ties are required, which alone is a great advantage, as no one (not acquainted with the expenditure of field artillery stores) can have any idea of the quantity of leather expended in ties in the course of a year; this, and the collar maker's time in making them, my hooks would save; but this is nothing, compared with the immense advantage of being able to free a horse when disabled, quickly from the carriage, perhaps under a heavy fire. Should a tie break, or become unfastened, there is nothing to prevent our present hook from coming out, and this might occur at a critical moment. In hooking-in in a hurry at night, drivers might mislay their ties, rendering the present trace-hooks nearly useless. This in a surprise by an enemy would be awkward, to say the least of it. For attaching the traces to the eye on the hames, I propose to adopt the hook used by the French; it requires no tie, and is much neater, and more easily made than ours; and one hook of my construction would be enough on each trace to free a horse when down, or on each swingle tree should the horse be attached in that way. I am trying a new pattern hames instead of our present collar and hames, which will not fit every horse, and are very hot and heavy. I hope to succeed so that the same hames and pads will fit any horse. A gentleman, formerly an officer of the regiment, to whom I was speaking lately on the subject, told me he had travelled in Norway for hundreds of miles with the same hames and pad,* changing horses at every stage, and he had never had an instance of galling; this is strong proof, that what I am trying to do, is quite feasible. I think nearly every part of our harness might be reduced in weight, and parts done away with without weakening it, and adding much to the appearance, as well as easing the horses of much unnecessary weight. Nothing can be worse than our drivers' whips, they are supposed to last for years, but from their material and make, do not last as many months, the least thing breaks them. An excellent whip was proposed some time ago by (I believe) Colonel Maude, consisting of a plain ash handle with the lash attached to it by a brass swivel, it would last for years, and always look well, whereas our present ones never do, except when quite new, as the bend of the lash soon breaks, and the handle becomes unbound and has to be patched with leather. Our blankets are unnecessarily large, and cannot be fastened properly on the horses. Horses rolling once or twice displace them and tear them off, and the wind blows them very much about when horses are picketed out. The white

* Instead of a collar, they have under the hames only two smooth pieces of wood pressed tightly against the neck of the horse.

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color is very bad, I think, as it is impossible to keep them clean; the mere putting them on in heavy marching order soon makes them look soiled. I would suggest their being made of a dark blue or brown colour and shaped so as to fit somewhat close to the horses, and to have a strap and cord to keep the ends down.

ADVANTAGE No. 9.—A different way of carrying the tents.

At present as they are carried on the sides of the wagon body boxes, there is no place left for the knapsacks. I propose carrying them underneath the wagon body, where the shoe boxes are now carried (the shoe boxes I carry between the ammunition boxes), by moving out the side supports of the boxes about 4 inches further from the perch, I get room enough for the tents to fit right up between, two in rear of the axletree bed, and two in front. I have four irons of this form with eyes for straps to pass through, and just the width of two picket posts and two tent poles placed side by side, (the tent is folded the same width). I buckle two irons in front of the axletree, and two behind; on each two of these, I lay two picket posts and two tent poles; and on these, which quite protect the bottoms from mud, &c., I lay my tent bags. A strap round the poles and each tent keeps them all together, for the purpose of carrying or lifting; after the irons are unfastened two men, one at each end of the poles, can carry the two tents, &c. any distance, each iron only requires one buckle to be undone to free it. The tent bags I have had made to open like a bed valise, instead of at the end, as it is very difficult to get the tents in and out of the present bags, when at all wet, I use straps instead of the lacing, being much easier fastened and unfastened. The tents placed where I propose, would be quite protected from rain by the wagon body, and would be less liable to mildew and rot in wet weather, the only time they would get wet would be in fording, but that is not a very frequent occurrence. I would be inclined to paint the bags, but I believe it has been considered for some reason, better not. The pin bags go on the platform between the knapsacks and the spare wheel. I think it would be a great improvement, if the pins were made of galvanized iron (as mentioned by Mr Galton, in his "Art of Travel"); they would last for ever, could not be used for firewood, and in rocky ground the wooden ones are useless, they would certainly be heavier, but I think much fewer would suffice. I am sure a much better form of tent might be adopted than the present bell tent, but into this I will not now enter.

In conclusion, I beg to say, that I would not have been able to have carried out my proposed alterations at all, or only very imperfectly, if the Deputy-Adjutant-General had not obtained the sanction of the Secretary of State for War, that I should receive any materials and assistance I required from the Carriage Department, and I take this opportunity of thanking Col. Tulloh for the assistance he so readily afforded me.

Since writing the foregoing pages, I have read that the French are thinking of discontinuing their horse artillery system. Should they do so,

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I only hope we will not (as in most military matters, good or bad) follow their example. Let us at any rate wait until experience shows what a perfect horse artillery, on the detachment system, can do against any others of a different organization.

I think, however, that the French having given so much attention lately to the best way of bringing gunners on the carriages into the field, should be an additional inducement to us to do the same; and shows, that what I have for a very long time thought of, and I hope, am now able to do, viz. to bring enough men into action with the gun to fight it for a time, will be a very important improvement in our field artillery system.

Notes on the Early History of the Royal Artillery, chiefly compiled from the Manuscript notes of the late Colonel Cleaveland. By Captain W. L. Yonge, R.A. *Dept.-Assist.-Adj.-General.*

[Read July 6, 1859].

Introduction.

It is a difficult matter to decide at what date the history of the Royal Regiment of Artillery, should really commence. The first mention of a *regimental* train of artillery, occurs towards the close of the 17th century, but in order to trace to its origin the formation of this regimental train, it will be necessary to refer in a cursory manner to the previous history of the artillery service, such as it was, commencing with the year 1660, the year of the restoration, alike of the Royal family, and the Royal army.

1659. About the year 1659, a general return was made of all the ordnance and stores appertaining thereto, which was to be found in the various castles and military posts in England, and among which the said ordnance and stores were divided as found most convenient, including such places as the Tower of London, Chatham, Sheerness, Tilbury, Woolwich, Portsmouth, Plymouth, Hull, Berwick, and some others. The exclusive superintendence of these garrisons, was at first given to a master-gunner and a firemaster, with their mates and some gunners, whose numbers varied at different times, and at the different stations, according to the importance attached to each. In consequence of many abuses which appears to have crept into the garrisons, the king (William III.) issued a warrant early in

1682. 1682 placing all the master-gunners under the authority of the Master-General of the Ordnance, and authorising him to examine them and turn out such as were not fit for service, "notwithstanding they might have been appointed by patent of the exchequer."

With regard to the number of gunners permanently employed at the various garrisons, those borne on the quarter-books of the Tower of London (which we may presume to have been of at least equal importance with the other garrisons) may serve as a fair illustration:—

The quarter-books for

March, 1661, gives	3	gunners at	12*d.*	52.
.....	1	.....	8	
.....	48	....	6	

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June,	1661, give	10	gunners at	12*d.*	}	
—	.....	3	.....	8	}	80
—	.....	67	.....	6	}	
Dec.	1662, ...	13	.....	12	}	
—	.....	5	.....	8	}	98
—	.....	80	.....	6	}	
—	1664	.....	..a total of			98
—	1670 }					
—	1671 }	.....				103

The increase in ten years was 51 gunners.

What the precise duties of these gunners were we have no direct evidence to show, but the rate of wages, varying from 6*d.* to 12*d.* per diem, would lead us to infer that it was little else than the actual superintendence of the ordnance in store, and the occasional "shooting off great guns" on high days and holidays. The duties of a gunner are thus described in Chalmer's Cyclopædia: "Gunners are officers of the Tower and other garrisons, whose business it is to look after the ordnance mounted in the lines and batteries, which are all fixed and ready with cartouches and ball, for service on the shortest warning. One or more of them are on duty day and night. They carry a field staff, and a large powder horn in a string over the left shoulder, in which equipage they march by the guns."

1675. The Artillery certainly had no regimental or army rank in the year 1675, for in a warrant of King Charles II. issued this year, and detailing the order of precedence of the various regiments, no mention whatever is made of the Artillery. That great importance was nevertheless attached to the artillery service we may conclude from the preamble to a warrant bearing date 25th July, 1683, addressed to Lord Dartmouth (who, as George Legge, had himself commanded the artillery of the British army in the Spanish Netherlands, in 1678), and which was as follows: "Whereas we have taken into our princely consideration and care, the great consequence and necessity of *preserving* the state of our artillery, munitions, arms, and of all the habiliments and equipages belonging to our magazine royal within the office of our ordnance, which hath *heretofore with much providence and wisdom of our predecessors*, been constituted and endowed, and supported *as a member highly importing to the safety and defence of our dominions*, as well by sea as land, &c." The same may be concluded from the fact that the quarter-book for July, 1679, contains an entry of the sum of £100 to Jonas Moore,[1] Esq., "for his better encouragement in the study of the mathematics, especially in the art of fortification, gunnery, and artillery, and such other parts thereof as may most conduce to his Majesty's service;" the grant was authorized by warrant, dated 1st October, 1677. A similar entry occurs "authorizing a sum of money to be paid to Richard Wharton, gentleman, for his encouragement to travel into foreign parts, and perfect himself in the studies of the mathematics, &c." Also to Captain Richard Leake,[2] master-gunner of England, "for exercise of schollars (*sic*) to shoot

[1] Sir Jonas Moore published several works on Artillery and Engineering, and some of these are to be found in the Royal Artillery Library, at Woolwich.

[2] Master-gunner of England, 21 May, 1677, died 1696, and buried at Woolwich.

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in great ordnance at the artillery ground." Again, "to John Tucker for his invention of a new way of shooting hand-grenades out of a small hand mortar-piece, which may prove of great advantage to his Majesty's service."

That the Artillery was occasionally exercised, we gather from an order addressed to the Master-General by the Duke of Monmouth as follows: "His Majesty having appointed a rendezvous of his Majesty's Horse and Foot Guards in Hyde Park, on Tuesday, the 23rd of this instant May, (1676), I desire you to cause 8 field pieces, viz. 4 demi-culverins, and 4 sakers brass ordnance, and 2 mortar-pieces, with all the carriages, and furniture thereunto belonging, together with 2 wagons, 2 tumbrills, and 4 tents, attended with a competent number of gunners, 50 pioneers and their respective officers in their best equipage, to attend the exercise of the said forces on the day above-mentioned, and that they fail not to be there by 8 of the clock in the morning at farthest."

1683. In the year 1683, a "Book of Instructions," was drawn up detailing the duties of the various officers of the Ordnance Department, and annexed to these instructions, there was "an establishment of the annual payments and allowances to be made upon the quarter-books of the Office of our Ordnance." After specifying the salaries of the principal officers from "the Master-General of our Ordnance for the time being £1,500," to the store-keepers of the various posts and castles (the junior of whom at St James Park received £20 per annum), there follows a list of the "under ministers," including the Master-gunner of England[1] at £190; his three mates each at £45; 60 gunners at 1*s.* per diem (£18. 5*s.* per annum); 44 labourers each £26 per annum. This may serve to show the position held by a gunner.

In the "Book of Instructions" before referred to, among the duties detailed as belonging to the Lieutenant-General of the Ordnance, is the following paragraph:—

"To take care that the train of artillery in our Tower of London, and all its equipage, be fitted for motion upon any occasion when it shall be ordered to be drawn into field for our service, and that all other trains in any of our magazines within our kingdom, be kept in good condition and ready for our service when required."

1684. One of the first occasions on which the train of artillery is mentioned, subsequent to the year of the Restoration, is on the issue of the king's warrant on the 24th August, 1684, to Lord Dartmouth, the Master-General of the Ordnance. His lordship had recommended to the king the re-organization of the garrisons in Ireland "for the better preservation of the remains of ordnance, ammunition, and habiliments of

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[1] 'The master-gunner of England is an officer appointed to teach and instruct all such as desire to learn the art of gunnery, and to administer to every scholar an oath, by which beside the duty of allegiance, obliges him not to serve any foreign prince or state without leave; nor to teach the art of gunnery to any but such as have taken the said oath; and to certify to the Master of the Ordnance, the sufficiency of any person recommended to be one of his Majesty's gunners.'—Chalmer's *Cyclopædia.*

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war." After pointing out that "whereas at present his Majesty's stores of war in that kingdom are dispersed unproportionably in 34 garrisons, as appear by the last remains, and that many of them are not only an unnecessary charge, but unsafe for his Majesty's magazines to be contained in," the warrant proceeds to direct that those garrisons "may be reduced to as few as may be with conveniency and safety, and that such as shall be adjudged fit to be continued may be well garrisoned, and put into better condition for his Majesty's service, and the defence of that his Majesty's kingdom against foreign invasion, or other hostile attempts whatsoever." For the furtherance of this object, an officer of the ordnance was sent into Ireland to take a remain of all "ordnance, ammunition, and habiliments of war." The result was, that the garrisons were reduced to about ten in number.[1] In addition to the pressing recommendation of the Master-General, the king's warrant proceeds as follows: "And whereas there was also an estimate presented to his Majesty by the said Lord Dartmouth, of the charge of all manner of necessaries to be provided for a train of artillery of 20 pieces of ordnance, and two mortar pieces, in that kingdom (Ireland), a copy whereof is also annexed, amounting to the sum of £1,267 10*s*., his Majesty in Council upon taking the same into consideration, was pleased to order that only one moiety for his Majesty's present service of the said proposed train, with necessaries proportionable according to the said estimate, should be sent into Ireland, and that the Right Hon. the said Lord Dartmouth, Master-General of his Majesty's ordnance, do forthwith take care that the same be done." Authority was at the same time given to draw upon the Treasury for the sum of £633. 15*s*., "being one moiety of the said estimate." In the suggestions annexed to the recommendation of the Master-General, "Athlone is represented as the most proper place for the lodging the train of artillery, and placing a good magazine of arms, ammunition, and all utensils of war, not only in respect of its being capable of being made strong, and that your Majesty hath a good castle already for the lodging your stores in, that commands the most considerable Pass, and will be as serviceable a garrison for Leinster as this province (Connaught), but that it is near the centre of the whole kingdom, so that the train and forces to be lodged here, will be most conveniently placed, and readiest to march to the succour of Ireland, whenever it shall be needful."

When artillery was required to accompany the troops in any expedition, a demand was made by virtue of the king's special warrant in each case, "on the principal officers of the ordnance, for the number of guns, and the requisite stores, ammunition, and equipages for the same;" and these were delivered over to the officer named, who was responsible for their use. Thus, when King James II. was collecting his army to oppose the rebellion excited by the Duke of Monmouth (16th June 1685), he issued a warrant to Lord Dartmouth, the Master-General of the Ordnance, directing him to order the storekeeper at Portsmouth to get ready a train of artillery, consisting of eight pieces of ordnance, viz. "four 3-prs. iron, nealed and turned, and

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[1] From a warrant of the 22nd March, 1687, it appears that the following garrisons were retained: viz. Duncannon, Cork, Kinsale, Charles Fort, Limerick, Galloway, Athlone, Londonderry, Carrickfergus, Culmore, Passage, Waterford.

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four brass falcons,[1] with all such stores, ammunition, and equipage, as he may judge requisite to attend the same for an immediate march." This warrant was issued on the 16th June, 1685, three days after the Court and Parliament in London received the intelligence of the landing of the Duke of Monmouth, at Lynn. A train of artillery was consequently prepared and despatched to join "*the present expedition under the Earl of Feversham, in opposing the treacherous practices and attempts of those rebels which are now openly in arms against us.*"

The following officers were appointed to this train, viz,—

	per diem. s.	d.
Comptroller, Henry Sheares, Esq.	15	0
His clerk	3	0
Commissary of ammunition for the train and army, Nicholas Sandford	10	0
Gentleman of the Ordnance, Richard Seahouse	5	0
Clerk to the Commissary	3	0

	per diem. s.	d.
Quarter-Master	5	0
Two conductors, 2*s.* 6*d.*	5	0
Firemaster	5	0
Master-gunner	5	0
Eight gunners at 2*s.*	16	0
Eight matrosses at 1*s.* 6*d.*	12	0

This was one gunner and one matross to each piece of ordnance, and these received double pay on service. The guns were thus given over to the care of the regiment with a small proportion of gunners, who had been exercised as above to "charge and shoot them off;" for on a subsequent occasion, when two 3-prs. were distributed to each of seven regiments at Hownslow (8th August, 1686), it is directed that the Grenadiers belonging to those regiments are to convey the field pieces to the appointed place. Of the officers, the firemaster appears to have been the chief artillery officer (if we may use the expression), for his duties are thus detailed in the "Book of Instructions" before quoted, "To exercise once or twice a week those that he hath under his command, with a great and small mortar-piece, to cast stones, bombs, and grenades, filled with sand, at several distances, and to keep them continually at work in the laboratory, &c. . . . . to shew them how to fill, fit, and apply a petard[2] for several occasions, and of several sorts." His duties in the field were evidently to superintend the troops in the use of the artillery of the train.

On the 21st June, 1685, a second warrant was issued to the Master-General, directing him to have in readiness a train of artillery, "*necessary at this juncture of time, when divers traitors and rebels are in open hostilities against us,*" consisting of sixteen pieces of brass ordnance, with the requisite stores, ammunition, and equipage from the stores in his charge, with all expedition, to march towards Chippenham in Wiltshire, to join the Earl of Feversham, whose orders the officers of the said train were to obey and observe.

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[1] 'The *falcon* was a 2½-pr., 7 feet long, and weighed 750 lbs. The charge was 2¼ lbs. of corn powder. This gun was drawn by three horses, or two yoke of oxen, and had a range from 260 to 1200 paces.'—*Animadversions of Warre.* By Robert Ward, Gentleman and Commander, London, 1639.

[2] '*Petards* are only used to blow open ports, and portcullis; they are divers in their magnitudes, according to the strength of the opposition they are to mine. Their proportions are,—some to hold one pound of powder and lesse; others to hold fifty or sixty pounds or more. They are fashioned like to a morter; or saint's-bell, somewhat tapered. A strong hooke is to be scrued into the substance you intend to mine, and upon this hook hangs the wringle of the petard, and likewise to be shored up with a strong forked rest to stay the reverse of it.'—*Ibid.*

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The following brass pieces composed this train: viz.

2 Twelve-prs.,	4 Sakers.[2]
4 Demi-culverins,[1]	2 Minions.
4 Six-prs.	Total 16,

with forty round, and fifteen case shot for each gun.

By the following list it will be seen that two gunners and two matrosses per gun, was considered a fair proportion :—

Officers and ministers appointed, with their pay per diem.

	s.	d.		s.	d.
Comptroller	15	0	1 mate	2	6
Clerk	3	0	1 tent-keeper	4	0
Commissary of munitions	10	0	1 adjutant	1	6
2 clerks, each	3	0	1 master-smith	4	0
Paymaster of the train	8	0	2 smiths, each	2	0
Clerk	3	0	1 farrier	2	0
Master of the wagons	10	0	1 master-carpenter	3	0
2 assistants, each	4	0	4 carpenters, each	2	0
Commissary of draught horses[3]	8	0	1 master-wheelwright	3	0
2 assistants, each	4	0	2 wheelwrights, each	2	0
2 gentlemen of ordnance, each	5	0	1 master-collarmaker	3	0
Surveyor	5	0	1 collarmaker	2	0
Provost-marshal	6	0	1 master-cooper	2	6
2 assistants, each	2	0	1 gunsmith	1	6
Master-gunner	5	0	Captain of pioneers	4	0
2 mates, each	3	0	Serjeant „	2	0
6 conductors	2	6	Corporal „	1	6
32 gunners	1	0	Drummer	1	0
32 matrosses	1	0	20 pioneers, each	1	0
1 surgeon	4	0	118 drivers	1	0

Among the stores were the following :—

Falling hooks (pairs)	20	Turnpikes[4]	8
Hurters	40	Stoccadoes	200
Ice cart	1	Mens' harness, 67 and 52 to a set of each	6
Sarsnet banners for wagons	40		

The pay per diem of the train was £22. 2*s*. 6*d*.

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[1] 'The regulation *demi-culverin* was a brass gun of 11 feet, weighing 3000 lbs., and projected a shot of 11¼ lbs. with a charge of 12½ lbs. of corn powder. It required 7 horses (or 4 yoke of oxen) to draw it. It had a point-blank range of 380 paces (of 5 feet), and carried at "*utmost random*" or extreme range 1800 paces. (The gun referred to in the text, was probably the *lesser demi-culverin*, which was also an authorized peece. This peece threw a ball of 9 lbs. with 7¼ lbs. of corn powder; was 10 feet long, and weighed 2,300 lbs. It was drawn by 6 horses or 3 yoke of oxen).'—*Animadversions of Warre.*

[2] 'The ordinary *saker* was of the following dimensions:—viz. length 9½ feet; weight 1900 lbs.; weight of ball 5¼ lbs.; charge 5 lbs. of corn powder; range from 300 to 1500 paces.'—*Ibid.*

[3] 'The Commissary of the draught horses is to take care of the draught horses and their drivers, as well of the ordnance as the carts and wagons.'—*Book of Instructions.*

'Against the army march, it is requisite he make provision that every piece hath his sufficient number of draught horses and oxen apt to draw the same, according to the nature of the ways, with sufficient attendants to assist upon all occasions.'—*Ibid.*

[4] ' The use of the *Turne-pike* and how it is framed, and of the excellent defence it makes, both against Horse and Foote upon all straights and passages."—*Animadversions of Warre.*

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The men attached to the train were armed as follows: viz.,

2 gunners' mates } each a field stave,[1]
32 gunners }
32 matrosses;[2] each a half-pike, and a hanger with belt,
Serjeant of pioneers; a partizan, and a hanger with belt,
Pioneer corporal; a halbert, and hanger with belt,
20 pioneers; each a hanger and belt, and between them { 8 pickaxes, 6 shovels, 6 spades,
Drummer; a drum, and hanger with belt,
Hangers with belts for the conductors, wheelers, carpenters, coopers, smiths, and collar-makers.

The following was the order of march of the foregoing train of artillery:—

"1st Division: Before the ordnance marched the carts, with spades, pickaxes, and hatchets.

Carts with harness.
Carts with gyns, hurdles, &c.

Before this division marched the captain of pioneers,[3] and his men.

After this as part of the 1st Division, followed the ordnance, the greatest pieces first.

Before the ordnance marched the general, lieut.-general, comptroller, and commissary of artillery.

By the side of the train, the master-gunner, and the gentlemen of the ordnance, every one to the division of guns allotted to them; and to every gun, the proper gunner and matross allotted to them.

After the ordnance followed:—

Carts, with budge barrels, cartouches, &c.
Tumbrills,[4] with iron and case shot.
A cart with gyns and matches (*sic*).
Carts with spare camp equipage.
The generals, lieutenant-generals, and other principal officers' wagons.

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[1] *Field-stave*, 'linstock.'

[2] '*Matrosses*; soldiers in the train of Artillery, next below the gunners; their duty is to assist the gunners in traversing, spunging, loading, and firing of guns, &c. They carry firelocks, and march along with the store wagons, both as a guard, and to help in case a wagon should break down.'—Chalmer's *Cyclopædia*.

'Likewise every peece hath his gunner, with his co-adjutor or mate, and a man to serve them both, and helpe them charge, discharge, mount, wadde, cleanse, scoure, and coole the peeces being over-heated.'—*Animadversion of Warre*.

[3] 'The Master of the Ordnance must have under his command a band of pioners, the captaine over them to be very discreet and carefull; he must likewise see these pioners be sufficiently guarded whilst they are at worke, lest the enemy surprise them.'—*Animadversions of Warre*.

The pioneers attached to the train were clothed in red jackets and red caps, and the artificers in red clothes, laced.

[4] From the Spanish '*tambarilla*,' a chest or trunk with an arched cover.

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Wagons of match.
Wagons of powder.
Wagons for tents, as well ammunition tents as others, with the tent-master and his servants.
Then carts of spare material.
Wagons for the smiths, marching forges, tools, &c., and those of carpenters, wheelers and other artificers.

Then followed the 2nd Division, which consisted of the ammunition for the foot and horse, viz.

Wagons of powder.
„ match.
„ musket, carbine, and pistol shot.
„ spare arms, and all other necessaries.
Bridge boats.

The 3rd Division consisted of the wagons and carriages that carry the standing magazine, and the utensils and provisions that are for the reserve of the train and army above the ordinary daily use."

"Upon all other wagons and carriages, proper conductors are to attend, who are responsible to render an account of all under their respective charges, and how the same are employed and expended."

Of the officers of the train, the wagon-master appears to have held the most responsible office as regards the effective state of the train. His duties are thus detailed in the "Book of Instructions," before referred to, "When the train of artillery marches, he is to look to all the wagons, carts, and carriages thereto belonging, and the drivers and carters; to order the loads and marches of the wagons and carts, and to see that the conductors appointed to attend the said wagons of ammunition and carriages of stores do their duty. He is to see good order, both in the marching and lodging of the wagons, carts, and carriages, that they clog not up the ways, nor hinder one another in marching, and to provide that the carters, wheelwrights, carpenters, smiths, and such other artificers as ought to attend them, do suddenly repair and amend any wagon, cart, or carriage that shall happen to break or receive any damage in marching; lastly, he is carefully to forecast that there be nothing wanting concerning his charge, when the train of artillery shall be ordered to march, or if there be any want, he is to acquaint the Master-General of our Ordnance, or Lieut.-General, and the rest of our principal officers therewith, and to have order for redress."

Monmouth, whose advance was disputed by the militia, at Bridport and Axminster, though he was welcomed at Taunton and Bridgewater, ultimately decided to besiege Bristol; but the Duke of Beaufort was resolved to defend the place to the last, and was enabled to carry out his resolve by the speedy approach of the Royal forces, when the siege was raised. Thence the rebels proceeded into Wiltshire, and on their arrival at Philips Norton, were surprised to find Feversham close at their heels. Despite a temporary reverse, which happened to his advanced guard, Feversham held his ground at Bradford, where he awaited the arrival of the train of artillery. Monmouth fell back upon Bridgewater, where he was overtaken

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by the Royal forces, under Feversham, with Churchill (afterwards the renowned Marlborough), in a subordinate command.

Then followed the battle of Sedgemoor, of which suffice it here to say, that after the defeat of the rebel cavalry, who commenced the action, and whose retreat caused inextricable confusion in the ranks of the infantry of the insurgents, the Duke of Monmouth, who had hitherto behaved with great bravery, mounted his horse and fled;—not so his infantry, who in spite of the repeated attacks of the Royal cavalry, made a stand until their ammunition failed them. At this period of the action, the king's artillery came up. It had been posted at about half-a-mile distance, but had hitherto taken no part in the action. "So defective were then the appointments of an English army, that there would have been much difficulty in dragging the great guns to the place where the battle was raging, had not the bishop of Winchester offered his coach horses and traces for the purpose."[1] Even when the guns had arrived, there was such a want of gunners, that a serjeant of Dumbarton's regiment (the 1st Royals) named Weems, was forced to take on himself the management of several pieces, and for which he received a gratuity of £40, "for good service in the action at Sedgemoor, in firing the great guns against the rebels." The cannon, though ill-served, brought the engagement to a close, and the rout was complete; the loss of the rebels being about 1000 men, or three times that of the Royal forces. "So ended the last fight deserving the name of battle which has been fought on English ground."[2] This defeat was speedily followed, by the capture and execution of Monmouth. Kirke and his "lambs," and Jeffreys, whose wholesale execution and transportation of the rebels was his proudest boast, soon put down all outward signs of rebellion; and in 1685, the king's power had reached its highest point. About this period, the king endeavoured to procure for his own form of religion more than tolerance, and with this view he did not hesitate, from time to time, to make encroachments upon the established religion of the state. Various acts of hostility to the Church of England, lashed the people into a state of agitation bordering on rebellion, but the king was determined not to yield. To overawe the metropolis, a camp of 30,000 men was formed at Hounslow, and the king issued his warrant "directing a train of artillery consisting of 26 pieces of ordnance with 3-pound bullets, with stores, equipage, officers, gunners, and other ministers, with all expedition to march and join the army at the rendezvous at Hounslow Heath, there to encamp; and further directing the preparing of teams of horses and drivers for the same, as Thomas Hardyman, commissioner of draught horses may require." These field pieces appear to have been returned to the Tower, in the month of August following, and two 3-prs. were distributed in Hyde Park to each of the following seven regiments, viz.,

Scotch Guards,
Royal Regiment,

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[1] Macaulay's History of England.

[2] Macaulay mentions that the best account of Monmouth's rebellion is to be found in the MS. journal, kept by Mr Edward Dumner, of the train of artillery, which book is in the Pepyrian Library, at Oxford. If a copy of this MS. could be procured for the Regimental Library, it would be an interesting record of the management of artillery in the reign of James II.

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Prince George's Regiment,
Holland's Regiment,
Earl of Bath's Regiment,
Colonel Kirk's Regiment,
Marquis of Worcester's Regiment.

The grenadiers of these regiments conveyed the field pieces to the appointed place. To the guns which were attached to the various regiments on the first formation of the Hownslow camp, the following addition appears to have been made in June of the following year :—

Brass ordnance,

2 demi-culverins of 12 feet long,
4 minions ..... 10 ...
6 three-pounders... 6 ...

and the following regimental guns :—

2 three-pounders for the Queen's Regiment,
2 . . . . . Princess' Regiment,
2 . . . . . Colonel Cornwallis' Regiment,
2 Falconets . . . . Sir E. Butes' Regiment,
2 . . . . . Colonel Fulton's Regiment,
2 three-pounders . . Colonel Boshan's Regiment,

also, 6 mortar-pieces of 7¼-inch diameter, on travelling carriages.

This made a total at the camp in 1687, of 26 regimental guns, 6 mortars, and 12 heavy guns. To these were attached the usual stores, ammunition, officers, gunners, bombardiers, and other ministers. The camp which was first formed in May, 1685, for the purpose of overawing the city, failed in this object, but was on the contrary a great source of amusement to the town, and so continued, until at last the sentiments of the army were exactly the same as those of the populace against whom it was intended to act.

The general satisfaction with which the famous acquittal of the bishops was received, was more than echoed by the soldiery at Hounslow, where the king received the news, and the camp was accordingly broken up in 1688, and the troops sent to quarters in different parts of the country. As the king thus failed in gaining the army to assist in his designs, he determined to call to his assistance the Roman Catholics of Ireland. With this view, several battalions of Irish troops were landed in England, and many Irish were drafted into the English regiments. This measure was most unpopular with the army, and in more than one instance, whole regiments refused to serve with the interlopers.

1686. Having disposed of the camp at Hounslow, we will return to the month of August, 1686, when the king issued his warrant to the Master-General, authorizing him to appoint sundry "fitting persons able to undergo the charge of gentlemen of the ordnance, to take the management, care, and oversight of the guns, as well of the respective trains, as of our several garrisons . . . . without which the ready effects of our artillery in either respect may, perhaps, be wanting when occasion shall be offered." The preamble to this warrant gives as the reason for its issue, "the great increase of our trains of artillery lately dispersed in several parts of our kingdom,

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for the benefit and advantage of our service, as likewise by the considerable number of our ordnance lately mounted for the better defence of our garrisons, and particularly that of our Tower of London."

With reference to the "mounting of guns in garrisons," there is a warrant to the Master-General, bearing date the 21st November, 1685, and referring to an indenture between King Henry VII. and the town of Dartmouth, by which the inhabitants were bound to fortify the town "by furnishing and garnishing with guns, artillery, and other ordnance, defensive and sufficient, a certain tower or bulwark therein, for the safeguard of the said town and parts adjoining; and from thenceforth for ever, to find a chain sufficient in length and strength to stretch, and be laid overthwart the mouth of the haven of Dartmouth, from one tower to another . . . in consideration whereof there was granted to the said town for ever, the annuity of £40 per annum, payable out of the Customs." This annuity was now confirmed by King James, and the Office of Ordnance was called upon to see that the town performed its part of the agreement. This seems to refer to a system of subsidy, which finds an illustration in the case of Londonderry, in Ireland; for when a *remain* was taken of the ordnance in that kingdom, as before stated, it was noticed with respect to this town, that most of the ordnance was marked with the arms of the various companies of the City of London.[1] Again, at Culmore Castle, where cannon were not mounted, was an establishment of £1. 9*s*. 4*d*. per diem for a captain, a gunner, and ten warders, paid by the City of London.

It has been mentioned, that there were mortar-pieces attached to the Hounslow train. On the 23rd November, 1685, it was ordered that all unserviceable brass ordnance at Woolwich, should be recast into mortar-pieces or other ordnance, as the Master-General might direct, for the better completing the several trains of artillery. In the following year, the king issued another warrant, expressing his "intention of casting more brass mortar-pieces of several sizes, and providing proportionable numbers of bombs, carcasses, and grenado shells,[2] as he is very well satisfied of the exceeding usefulness and advantageous execution of that sort of artillery, now in practice according to the modern art of war, more than formerly. And forasmuch, as without the assistance of able persons well qualified and experimented in the practice of the said artillery, little or no use is likely to be made of them, when our service shall call for the same, our will and pleasure is, and we do hereby authorize you to enter upon the quarter-books of the office of ordnance as an addition to the officers, ministers, and attendants, within the said office by the former instructions already established,

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[1] 'On the bastions were planted culverins and sakers, presented by the wealthy guilds of London to the Colony (of Londonderry). On some of these ancient guns, which have done memorable service to a great cause, the devices of the Fishmongers' Company, of the Vintners' Company, and of the Merchant Tailors' Company, are still discernable.'—Macaulay, Vol. III. p. 142.

'Here and there, among the shrubs and flowers, may be seen the old culverins which scattered bricks, cased with lead, among the Irish ranks. One antique gun, the gift of the Fishmongers of London, was distinguished during the 105 memorable days, by the loudness of its report, and still bears the name of "Roaring Meg." '—*Ibid.* p. 240.

[2] From '*granata*,' a pomegranate, which this missile originally resembled, being filled with broken glass, similar to the stones of the fruit.

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1 chief bombardier at 3*s.* per diem.
12 bombardiers ..... 2*s.* „
1 chief petardier..... 3*s.* „
4 other petardiers ... 2*s.* „

all of them to be nominated, constituted, and appointed from time to time, by the Master-General of our Ordnance, and to be under the direction and guidance of our master-firemaster, strictly ordering and commanding that in the choice of the said bombardiers, all diligent circumspection be used, and that you suffer none to be admitted to the said employment, but such only as you shall be really assured are of sufficient knowledge and abilities for that our service; and further, our will and pleasure is, that the said number of bombardiers and petardiers before mentioned, be in the quarter-books of our said office, and receive out of the treasury thereof, quarterly, the several pays, allowances, and entertainments, hereby to each of them made and established during our Royal pleasure.

"By his Majesty's command,
" (Signed) SUNDERLAND."

In the quarter-book for December of this year 1686, we find the following to be the strength of the "inferior ministers," viz.

1 chief bombardier (Daniel Moody),
12 bombardiers,
1 chief petardier (John Fawcett),
4 petardiers,
60 gunners.

With the increase of the standing army, King James II. was also bent upon making his artillery as efficient as possible; the supply for its maintenance was but scanty, and the king endeavoured to make quality atone for the want of quantity. With this view, we find a warrant issued on the 29th March, 1687, with the following preamble: "Whereas we think it requisite for the good of our service, that some fitting person should be sent into foreign parts to improve himself in the art military, and to survey, learn, and observe the best manner and method of fortification and modern practice of artillery," &c. The warrant then proceeds to grant to Edward Clarke, gentleman, the sum of 20 shillings per diem during his absence upon this service, and to authorize a grant of money to him to defray expenses. Edward Clarke was directed to take a journey to Hungary with all convenient speed, "and to repair to the emperor's army or armies this next campaign, and there to observe and take notice of their method of marching, encamping, embattling, exercising, ordering of their train of artillery; their manner of approaching, besieging or attacking any town; their mines, batteries, lines of circumvallation, and contravallation; their way of fortification; their foundries, instruments of war and engines, and what else may occur observable in his journey thither," and to report accordingly. Mr Jacob Richards was present at the siege of Breda, by the imperial army under the Duke of Lorraine, having been sent by the Master-General, Lord Dartmouth, for improvement for the king's service.

It will not be here attempted to follow all the numerous trains which were raised by the king about this time, and for various purposes, but it may

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not be amiss to enumerate a few of them. The train prepared to resist Monmouth, despatched from Portsmouth, 16th June, 1685, and consisting of 8 pieces, was reinforced (or rather supported, for the two trains never appear to have joined), by another ordered to Chippenham, 21st June 1685, which consisted of 16 brass pieces.

1685, 14 June. A train consisting of the following pieces of ordnance, prepared at Portsmouth:—

Four iron ordnance, nealed and turned, 3-prs. of 5 feet.
Four brass falcons of 6 feet.

1686, 12 May. Field Train; proportion formed 12th May, "for the encampment on Hounslow Heath of our Royal guards, as well horse as foot."

Brass ordnance 3-prs. light, mounted on travelling carriages and limbers complete . . . . . } 26.

The following tents were sent:—

His Majesty's tents,
Great tent, with pavilion gallery.
2nd tent, with gallery.
3rd and 4th tents, with walls.
5th tent, containing 4 rooms and 2 closets.

Octagon tent 17ft. diameter.
„ 9 „
„ 7 „
German tent.
Pavilion tent 16 ft. square.

Persian tent in 14 parcels.
Kitchen tent 26 × 13 feet.
Stable tent 36 × 16 „
A tent 20 × 11 „

For the king's guard:—
A tent 32 × 16 feet.
Officers on guard 16 square.

For the Green Cloth office: a tent 14 ft. long with octagon ends.

Lieut-Generals of the army, each
Octagon tent 9 ft. diameter.
A tent 13 × 10½,
A tent 9 × 9.

Major-Generals of the army:—
A tent 16 ft. long, with octagon ends.
A tent 13 × 10½.

For prisoners: a tent 16 × 12.

Lieut-General of the Ordnance:—
A tent 30 × 15.
Pavilion tent 30 × 15.
Hall tent 14 × 11.

Principal officers of the ordnance, each a tent 14ft. long with octagon ends.

Kitchen tent 35 × 20.
Lieut-Colonel 27 × 11.
Major..... 18 × 12½.
Captain ..... 10 × 7.
Lieutenant... 8 × 6.

Adjutant ..... 13 × 8.
Quarter-master 13 × 6.
Surgeon ..... 20 × 14.
Gunsmith ..... 9 ft. square.

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On the 1st November, 1688, the Prince of Orange landed in England, and a train of 26 pieces was immediately organized to "attend his Majesty's forces, consisting of 15,000 foot and 5000 horse." The warrant for this train bears date, 8th Nov. 1688, although a preparatory warrant was issued in the previous month, as follows:—

1688, 15 Oct. "JAMES R.

"Right trusty and well-beloved, we greet you well. Forasmuch as we have received undoubted advice that a great and sudden invasion with an armed force of foreigners will speedily be made in an hostile manner upon this our kingdom, we find it necessary at this juncture of time to have in readiness a marching train of artillery with all other necessary stores and equipage thereunto belonging, our will and pleasure is, and we do hereby authorize and require you to provide and to cause to be made ready for our service, a train of artillery of twenty pieces of ordnance and six field mortars, with all necessary stores and equipage thereunto belonging, to march upon orders sent from us or any of our Lieut.-Generals appointed to command our forces; and our further will and pleasure is, that the list presented by you unto us and hereunto annexed of the officers and ministers fitting to attend the said train if we go in person (which by us is approved of), be established according to the several pays per diem proposed, but if we should not think fit to march with our army, the attendance of the officers mentioned in the margin will not be necessary; and that out of such monies as are and shall be issued to the use and service of our ordnance, you cause such sums of money to be advanced as you shall judge reasonable for the present towards the defraying of the charge of the said train upon the expedition commanded, and also from time to time you cause such other sum or sums of money as shall be required for the defraying of the pays of the several officers and ministers, and carrying on our said service, to be duly made, allowed, and distributed, and for so doing this shall be your warrant.

Lieut.-General.
Comptroller-General.
Principal Engineer.
Master-gunner of England, and their clerks.
Chief Firemaster, and mate.
Keepers, and makers of our Royal tents, and their assistants.

"Given at our Court at Whitehall,
this 15th day of October, 1688,

"By His Majesty's command,
"MIDDLETON."

"To our right trusty and well-beloved
counsellor, Geo. Lord Dartmouth,
Master-General of the Ordnance."

The list includes,—

Chief firemaster, and mate.
Firemaster to the train, and mate.
4 assistants.

	s.	d.		s.	d.
Chief bombardier	3	0	4 petardiers.....	2	0
12 bombardiers, each ...	2	0	30 gunners at	2	0
Chief petardier	3	0	40 matrosses.....	1	6

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The matrosses on this service were clothed as under,—
Striped jackets and breeches,
Blue stockings,
Leather caps.

The pioneers,—

Red cloth coats,	Woollen stocking,
Red kersey breeches,	Shoes and buckles,
Leather Montreur caps,	Neckcloths.

Conductors,—Red cloth cloaks.
The chief engineer,—A suit of silk armour.
The matrosses were armed with half-pikes and hangers.

1689. King James II. having fled the kingdom on the 23rd Dec. 1688, landed at Kinsale with a French force of about 5000 men, in the month of March following. Consequently, on the 1st June, 1689, we find mention made of a train issued out of the magazines, and shipped for Ireland. This train was composed of the following pieces, viz., 2 culverins, 4 sakers, twelve 3-prs., and 5 brass mortar-pieces, a total of 23 pieces; and was re-inforced by three 3-prs., ordered by land to Chester, on the 4th July, 1689; and again, by 4 minions, likewise ordered to Chester, on the 9th of the same month, making a total of 30 pieces, in addition to a train previously sanctioned for Ireland, on the 22nd March, 1687.

1691. On the return to England, of King William III., after the battle of the Boyne, we hear of no more levies, until the king in the year 1691, set out for Holland with Marlborough, to take the command of the army against the French. The king did not land in Holland until June, 1691, but on the 27th of the previous February, a warrant was issued to prepare "a train of brass ordnance, with all fitting equipage, to be forthwith transported into Flanders for our service." The following were the guns of this train, and it will be observed, they were all light ones, viz.,

8 Demi-culverins,	4 Howitzers,
10 Sakers,	2 Small Petards.
20 Three-prs.,	

The officers of this train were,
Colonel J. Wynant Goor, at £2 per diem, 1 Ap. 1692.
Lieut.-Colonel Jacob Richards, at 19*s*. „
Major J. Simon Schlundt, at 16*s*. „

On the following day, another warrant was issued for a train of artillery of 76 pieces "for this summer's expedition by sea." The train was originally composed of the following pieces, viz.,

Fourteen 24-prs.	Ten 3-prs.
Sixteen 18 „	Eight 13-inch mortars
Eight 12 „	Twelve 10 „ „
Six 6 „	Two 8-inch howitzers.

1692. On the 1st May, 1692, the necessary warrants were issued to the officers of this train, and the following was the detail:—

Colonel Sir M. Beckman, Knt., £2 per dm.	Quarter-Master, Matthew Purcell.
Lieut.-Col. George Browne, at 19*s*.	Chaplain.
Major J. H. Hopeke, at 16*s*.	Paymaster and assistant.
A comptroller, and his clerk.	Master-surgeon.
Capt.-Lieut. Vanderstein.	2 assistants.
Battery-master, Anthony de Yonge.	92 gunners, at 2*s*.
His assistant, Edward Cork.	92 matrosses, at 1*s*. 6*d*.
Adjutant, Claude Tedfoil.	

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It will be observed that the train was authorized in February, but the officers were not appointed until the following May, when Sir M. Beckman arrived at Ostend with some detachments of artillery. It is probable that the guns were forwarded to the Continent as they were ready.

1693, March. In March, 1693, a royal warrant was issued authorizing the following addition to the Flanders Train of 28th Feb, '91-2, viz.,

Four 6-prs.
Two 3 „
Four 6 „ chamber pieces.

These were to be added "to the eight brass mortar pieces of 13 inches now remaining at Ghent," and where they were to remain until further orders. An addition was also made to the staff of the train. At Ostend, Sir M. Beckman was joined by Colonel Goor,[1] and Albert Borgard, who about this period entered the British service under the auspices of the king. We find the British artillery engaged in all the actions and sieges of the period, including the battles at Steinkirk (1692), and Landen (1693), and sieges of Namur (1692, '95) and Huy (1694).

The warrants of 28th February, '91-2 and March '93, authorized the material for a train of 86 pieces, but it can only be traced that the "eight mortar pieces of 13 inches" were actually despatched on those dates. The first of these warrants states that the train (of 76 pieces) was for "service by sea." Therefore, on the 6th May, 1693, the Queen (Mary) issued a warrant to Sir H. Goodriche, Lieut.-General of the Ordnance, directing "a train of brass ordnance and mortars, ammunition, stores, and habiliments of war, with the officers, ministers, and attendants of the said train to be *shipped* on board such ships as shall be provided."

The *detail* of the previous warrants appears to have been altered, but the total number of pieces "shipped" was 78, which, with the 8 mortar pieces at Ghent, would make the authorized 86 pieces, the whole under the command of Sir Martin Beckman.

1692, 4 Aug. In the meantime, on the 4th August, 1692, during the king's absence in Flanders, the queen issued a warrant for "brass ordnance and mortars, with their equipage, stores, and habiliments of war, with engineers, bombardiers, gunners, and matrosses," to be sent to the West Indies, where a descent from the French was expected.

The ordnance of the train was as follows :—

6 sakers, (a 6-pr.) with travelling carriages.
2 11-inch. with bodies of carriages (*sic*).
4 petards.

1693, 5 Mar. On the 5th March, 1693, the king issued a warrant to Viscount Sidney, the Master-General, directing an additional train of brass ordnance, ammunition, and stores, with officers, gunners, &c., for service in Flanders, viz.,

10 demi-culverins.	20 3-prs.
30 sakers.	4 8-in. howitzers.

These were placed under the command of Colonel Goor. Among the staff of this train we find the "kettle drummer" and "his coachman."

[1] Colonel Goor had served a previous campaign in Flanders, having commanded in the trenches at the siege of Mentz, in 1689. Albert Borgard joined the British Artillery at the Camp at Melle, 1692.

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1693, 11 Sep. On the 11th Sept. 1693, Her Majesty ordered the Lieut.-General of the Ordnance to provide "mortars, carcasses, grenado-shells, powder, arms, and other provisions and stores of war, with officers and attendants as specified in the annexed list, to be put on board our bomb vessels, the 'Serpent,' 'Mortar,' 'Firedrake,' 'Grenade,' and such other vessels as shall be provided."

Mortars, 13-inch, ... 8.
Matthew Purcell, Commissary, at 8*s*.
John Henry Hopkey, firemaster, 10*s*.
17 fireworkers, at 5*s*. each.

These vessels formed part of the fleet under Admiral Benbow, which bombarded St Malo in November, 1693.

The following incident connected with the expedition is interesting.

"The contrivance of firing mortars from ships at sea was then a new invention, having been first used about twelve years before by one Renaud, a young Frenchman, who had never seen an action. To increase the effect of the bomb vessels that were sent with the fleet on this occasion, a new galliot of about three hundred tons burthen was so contrived as to be itself one great bomb, capable of being discharged wherever she could float. In the hold of this galliot, next the keel, were stowed 100 barrels of powder; and as the effect of powder is always in proportion to the resistance, this layer was covered with a flooring of thick timber, which was perforated in several places, to admit the train that was to communicate the fire. Upon the top of this floor were laid cannon bullets, chain shot, great bars of iron, and an incredible variety of combustible matter, including grenades and carcasses. This galliot was called the 'Infernal.' After several days bombarding the city, on the 19th Nov., preparations were made for playing off the 'Infernal;' an engineer being put on board, carried her under full sail to the foot of the wall where she was to be fired, notwithstanding all the fire of the place against him; but the wind suddenly veering, forced him off before the vessel could be secured, and drove her upon a rock, within pistol shot of the place where she was to have been moored. The engineer set fire to the train and left her, when she blew up with an explosion that shook the whole city like an earthquake, uncovered above 300 houses, threw down the greater part of the wall towards the sea, and broke all the glass, china, and earthenware for three leagues round. The consternation of the people was so great, that a small number of troops might have taken possession of the place without resistance; as it was, they demolished Quince Fort, carried off eighty prisoners, and awakened the whole French nation from their golden dreams of the empire of the sea."

In consequence of the numerous trains equipped about this period, and the consequent drain upon the gunners of the kingdom, the king issued the following warrant to Sir Henry Goodriche, the Master-General of the Ordnance:—

1692, 6 March. "Right trusty and well-beloved, we greet you well. Whereas you have represented to us that by reason of the great scarcity of field gunners at this juncture, to serve us abroad, it is necessary for our service that draughts of experienced gunners be drawn out of our several garrisons, castles, and fortifications in England, to serve us abroad, and

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their vacancies, if our service shall so require, to be supplied by practitioner gunners. Our will and pleasure therefore is, and we do hereby authorize and empower, and direct you from time to time, to cause such draughts of field gunners to be made accordingly for our service abroad, and when you shall find it necessary for our service, you cause their vacancy to be supplied by practitioner gunners as aforesaid, and for so doing, this shall be as well to you as to all and every of our Governors, Lieut.-Governors, or Deputy-Governors of our said garrisons, castles, and fortifications, a sufficient warrant.

"Given at our Court at Whitehall,
this 6th day of March, 1692,
"In the fifth year of our reign.

"By His Majesty's command,
"NOTTINGHAM."

"To Sir Henry Goodriche, &c."

The estimates for the same year, include the pay of

5 engineers	at 10*s.*	12 bombardiers	„ 2*s.* 6*d.*
1 chief firemaster	„ 5*s.*	2 commissioners	„ 8*s.*
1 firemaster and petardier	„ 5*s.*	4 clerks of stores	„ 4*s.*
10 firemasters	„ 5*s.*		

In addition to the foregoing, there was also a staff of artificers who do not appear to have been *attached to the regimental train of artillery* as such, but who supplied some of their number as occasion required, to the different trains detached on foreign or other service. Although the bombardiers and petardiers above-mentioned, were provided for in the estimates, they belonged to the permanent staff for artillery purposes, and were not attached to the artillery companies as non-commissioned officers, as were the serjeants of gunners and pioneers. They were the same authorized by the Royal warrant of the year 1686, before quoted, and their duties were as there detailed, viz. to superintend the firing and working of the bombs or mortar-pieces then generally introduced into the service. For example, the warrant detailing the constitution and staff of the train of artillery in Ireland (22nd March, 1687), included no bombardiers, for the original train does not appear to have comprised any mortar-pieces; but a subsequent warrant of 8th Nov. 1688,—the period of the Irish sieges,—includes one chief bombardier, 12 bombardiers, and 4 petardiers; but even at this time no mortar-pieces were sent to Ireland, and the appointment of these bombardiers and petardiers was cancelled by another warrant. (We find, again, that an increase of the Irish Train included one 18-inch mortar, and four 10-inch mortars). The Flanders Train of Feb. 1691, included 4 bombardiers at 2*s.* 6*d.* each.

Having endeavoured (by the enumeration of several trains, organized at different periods) to give an idea of the system in force, for providing the army with artillery, but without attempting to follow them in their respective campaigns, the opportunity presents itself for noticing the formation of the first Regimental Train of Artillery.

Though I very much doubt whether the artillery at this period had any regimental organization, yet in the year 1693, the Flanders establishment consisted of four companies, and a company of bridgemen, or "tin-boatmen,"

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as they appear to have been called. Without pretending to fix definitely the first formation of *companies* of artillery, the annexed detail is that of four companies then in Flanders. A reference to the details of the several trains before enumerated, will show that there were in Flanders, in 1693, about 137 gunners. This number, divided among four companies, will give 34 to each, which is nearly the number hereafter detailed as the strength of each company. A comparison of the names of the officers in these "four companies" with those of the various trains, will also tend to show that the *personnel* of the companies was composed of the members of the several "trains."

Regiment, consisting of Four Companies.

1st Company.

	£	s.	d.
Captain, George Leslie	0	12	0
Lieutenants:—			
1st, George Spencer	0	8	0
2nd, Andrew Bonnett	0	7	6
Gentlemen of the Ordnance:—			
1st, Edward Grover	0	5	0
2nd, Thomas Raskall	0	5	0
4 serjeants of the gunners at 3s.	0	12	0
36 gunners at 2s.	3	12	0
4 corporals of the matrosses at 2s. 6d.	0	10	0
56 matrosses at 1s. 6d.	4	4	0

2nd Company.

	£	s.	d.
Captain, Abraham Decock	0	12	0
Lieutenants:—			
1st, Daniel de Young	0	8	0
2nd, Peter Gelmuyden	0	7	6
Gentlemen of the Ordnance:—			
1st, Joseph Durden	0	5	0
2nd, Samuel North	0	5	0
4 serjeants of the gunners at 3s.	0	12	0
36 gunners at 2s.	3	12	0
4 corporals of the matrosses at 2s. 6d.	0	10	0
56 matrosses at 1s. 6d.	4	4	0

3rd Company.

	£	s.	d.
Captain, Jonas Watson	0	12	0
Lieutenants:—			
1st, John George Brittenstein	0	8	0
2nd, William Bousfield	0	7	6
Gentlemen of the Ordnance:—			
1st, John Hillibon	0	5	0
2nd, John Gonson	0	5	0
4 serjeants of the gunners at 3s.	0	12	0
36 gunners at 2s.	3	12	0
4 corporals of the matrosses at 2s. 6d.	0	10	0
56 matrosses at 1s. 6d.	4	4	0

4th Company.

	£	s.	d.
Captain, Leonard Vanderstam	0	12	0
Lieutenants:—			
1st, Albert Briluis	0	8	0
2nd, Abraham Butler	0	7	6
Gentlemen of the Ordnance:—			
1st, Joseph Lamotte	0	5	0
2nd, William Gunn	0	5	0
4 serjeants of the gunners at 3s.	0	12	0
36 gunners at 2s.	3	12	0
4 corporals of the matrosses at 2s. 6d.	0	10	0
56 matrosses at 1s. 6d.	4	4	0

Bridgeman, or Tin-boat Men.

	£	s.	d.
Captains:—			
1st, William Van Erp	0	6	2
2nd, Thomas Glandall	0	6	2
Lieutenant, Thomas Morrice	0	4	0
4 corporals at 2s. 6d.	0	10	0
50 private men, ten to be English watermen at 2s.	5	0	0
Master tinman	0	5	0
2 assistants at 3s.	0	6	0
5 engineers, at 10s. each:—			
John Bodt, John Manclere, Isaac Cock, Michael Richards, Daniel Sherrard	2	10	0
Chief firemaster, John Doling	0	5	0
Firemaster and petardier, John Lewis Schlundt	0	6	0
10 firemasters at 5s. each:—			
John Chanternell, John Abrecht Churdes, Albert Borgard, Olans Hulk, Henryck Lunenburg, John Suit, Erick Schiller, John Spicker, William Hendricks, John Bleckenback	2	10	0
12 bombardiers at 2s. 6d.	1	10	0
2 commissioners at 8s. each:—			
Matthew Smallen, Robert Welsh	0	16	0
4 clerks of stores, at 4s.:—			
Thomas Edwards, Hedmaine de Weess, Thomas Fletcher, John Bourden	0	16	0
Conductor and plumber	0	4	0
28 conductors, at 3s.	4	4	0
2 conducters and coopers at 3s.	0	6	0
Master carpenter	0	6	3
2 mates at 3s.	0	6	0
20 private men at 2s. 6d.	2	10	0
Master wheelwright	0	4	0
6 wheelwrights at 2s. 6d.	0	15	0
Master smith	0	4	0
6 smiths at 2s. 6d.	0	15	0
Master collar-maker	0	4	0
6 collar-makers at 2s. 6d.	0	15	0
Master tent-maker	0	4	0
Assistant	0	2	6

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Pioneers.

Lieutenant, Robert Guybons	0	4	0
4 serjeants at 2*s.*	0	8	0
54 pioneers at 1*s.* 2*d.*	3	3	0

Detachment of Artillery ordered to Guernsey.

Fireworker, Henry Brass

3 bombardiers	20 carpenters
4 wheelers	3 masons
3 smiths	7 bricklayers
1 collar-maker	3 labourers.

It would exceed the limits of the present paper to attempt to follow the artillery during the campaigns in Flanders until the year 1697, but it may not be out of place to refer to the siege of Huy, which place surrendered
1694. on the 19th September, 1694. This siege was particularly remarkable for the fine and numerous artillery (one hundred and twenty pieces) which was employed at it, and for the dexterity with which it was managed. The British artillery at the siege of Huy was under the command of Lieut.-Colonel Browne.

1695. The siege of Namur, planned and executed by King William in person, commenced on the 3rd July, 1695. This was one of the strongest places in the Netherlands, and was deemed a masterpiece of the military art. It capitulated on the 1st September, although defended by a marshal of France, with an army of 15,000 chosen troops for his garrison, and 120 pieces of cannon, with another army more numerous than the allied army, in view to relieve it. The British artillery was extremely active at the siege, under the command of Colonel Goor, with Lieut.-Colonel Browne, as second in command. This latter officer threw a shell into the enemy's magazine in a demi-bastion, and destroyed it. Albert Borgard was present at this siege.

Colonel Sir M. Beckman was employed with bomb-vessels at the bombardment of St Martin's and Olonna, in July, 1695. These vessels threw 2000 bombs into those places.

Colonel Jacob Richards commanded five bomb vessels under Lord Berkley, at the bombardment of St Malo (4th July, 1695). They fired 900 bombs with great success.

Granville, destroyed by Colonel Richards with eight bomb vessels, assisted by frigates (8th July, 1695).

Dunkirk, bombarded 1st August, 1695, by Colonel Richards and Lord Berkeley's fleet.

Calais, bombarded by Colonel Richards and Lord Berkley's fleet (17th August), the English artillery throwing 600 shells from their bomb-vessels.

On the 10th December, 1695, the king directed a company of pioneers to belong to his train in Flanders, to be raised and continued in constant pay.

1696. The estimates for the ensuing year were laid before Parliament on the 28th October,

For the train, £210,773. 4*s.* 5*d.*

1697. On the 15th March, the king issued a warrant to the Master-General, Earl of Romney, directing a train of brass and iron ordnance, and several brass mortar pieces, &c., to be in readiness for Newfoundland.

Brass Ordnance	Sakers.....	6
Iron	Demi-culverin	12
	Minions	6
Brass Mortar Pieces, 7¼ inch		3
Brass Petards		6

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From the detail it would appear that only 3 gunners could be allotted to this train, together with 21 "practitioner" gunners.[1]

On the 19th Oct. 1697, the peace of Ryswick was proclaimed in London, and the whole of the British Artillery in Holland, embarked for England. Up to this date there was no regular Regiment of Artillery, but as we have seen, special trains were equipped by virtue of the Royal warrant, and certain officers and ministers were attached to each. The guns of a train were in general worked by the ordinary troops of the line, under the direction of the trained bombardiers, petardiers and gunners, who were drafted from the Tower, or some of the other garrisons of the kingdom. These were permanently maintained on the quarter-books of these garrisons, and were liable to be called upon to serve wherever required, either on board the bomb-vessels of the fleets, or as attached to the trains of artillery. In this manner, we find that there were several distinct trains in the service. When the services of the members of one train were no longer required, the bombardiers and others were drafted for service in other trains. We therefore find that the same officers were generally employed in different services, either in the king's expedition to Ireland to resist James II., or in the Flanders campaign, being transferred from one to the other as circumstances required. In 1693, the several trains in Flanders appear to have been organized in companies, as already mentioned, and on their return to England in 1698, dispersed. Such being the case at the close of the war, the king issued his warrant on the 24th May, 1698, for the establishment of a small regimental train of artillery, composed chiefly of those persons who had served faithfully during the war. On the organization of this train, it was provided that all such persons who had quitted bombardiers' or gunners' posts in the old Flanders establishment of 1693, to be advanced in the train of 1698, should (in case this latter were reduced) resume their former posts in the old establishment, notwithstanding any warrant granted to other persons for the same. The following is the warrant:—

1698, 24 May. "Whereas we have thought fit (now that a peace is concluded) to dismiss as well the Trayn of Artillery that has served us during the late Wars in Flanders, as also the several Trayns that have been employed in our Service by Sea. Yet that such persons as have served Us well and faithfully during the War, might have some reasonable provision made for their subsistance in time of peace, and for having of a Trayn of Artillery in greater readiness to march upon any occasion for the necessary defence of Our Realms and Dominions, We have thought fit to direct, that a small Trayn of Artillery should be composed of such Persons as have served Us well in the said Trayns during the War; And the annexed Scheme of such a Trayn of Artillery having been accordingly prepared, and laid before Us for our approbation, We have perused and considered thereof, and do hereby approve of, and establish the same to be entertained in Our service and kept in Our pay in time of peace untill such time as We shall think fit to signify our further pleasure therein. Our Will and Pleasure therefore is and We do hereby authorize and direct you out of such money as shall at any time be paid into the Treasury of Our Ordnance on account of Land service, to cause the several sums and yearly allowances mentioned in the

[1] *Vide* Warrant, page 136.

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said annexed scheme, amounting in the whole to £4,482. 10*s.* to be paid to the respective Officers, Engineers, Gunners, and others therein mentioned, the said allowances to commence from the 1st day of this instant May, and to continue during our pleasure. And We do hereby further authorize and empower you as often as any vacancies shall happen on this Our establishment by the decease of any person now placed thereupon or otherwise, to fill up the same with such persons as have served in any of Our above mentioned Trayns and could not at present be provided for, or with such other persons as shall apply themselves to study Mathematicks, and duly qualify themselves to serve as Engineers, Fireworkers, Bombardiers or Gunners on Our said Establishment, &c.

"At Our Court at Kensington,

"By His Majesty's command,

"(Signed) J. VERNON."

"To Earl Romney,
"Master-General of the Ordnance."

The following was the strength of the Regimental Train of Artillery as established by the foregoing warrant, and the total expense of which was £4,482. 10*s.* 0*d.*

	£.	*s.*	*d.*
Staff:—			
Colonel (on the old establishment)			
Lieut.-Col. (additional to his pay on the old establishment)	55	5	0
Major	50	0	0
Comptroller	45	0	0
Adjutant	60	0	0
1st Company:—			
Captain	100	0	0
First lieutenant	60	0	0
Second lieutenant	40	0	0
2 gent. of the ordnance (paid on the old establishment).			
2 serjeants 1*s.* 6*d.* each	54	15	0
15 gunners on the old establishment.			
15 gunners 1*s* each	273	15	0

2nd, 3rd, and 4th Companies the same as the first, with the exception of two gent. of the ordnance who were paid on the new establishment at the rate of £40 each.

Engineers:—		£.	*s.*	*d.*
6 engineers	£100 each	600	0	0
4 sub-engineers	50 „	200	0	0
2 firemasters	100 „	200	0	0
12 fireworkers	40 „	480	0	0
12 bombardiers	36 10*s.*	438	0	0
	Grand total	£4,482	10	0

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The following were the officers of this train, viz.

Companies:—

Colonel, Jacob Richards.
Lieut.-Colonel, George Browne.
Major, John Sigmond Schlundt.
Comptroller, James Pendlebury.
Adjutant, Albrecht Borgard.

Captains.

1 Jonas Watson,
2 Edward Gibbon,
3 Edward Williamson,
4 Wm. Bousfield.

1st Lieutenants.

1 Ralph Wood,
2 Thomas Raskell,
3 Peter Gilmuyden,
4 Geo. Brittenstein.

2nd Lieutenants.

Joseph Durden,
Andrew Boswell,
Edw. Glover,
Geo. Spencer.

Firemasters.

(Captains).

J. L. Schlundt,
Rob. Guybon.

Gentlemen of the Ordnance.

Ed. Silvester,
Matthew Purcell,
Christopher Briscoe,
William Gunn,
Nic. Whittaker,
Daniel Cohen (?),
Thos. Morris,
Rob. Welch.

Many of the above names are to be found on the establishment of the train of 1693.

The following is the detail of this regimental train "to be kept in pay in time of peace," established from 1st May, 1698.

Colonel.
Lieut.-Colonel, George Browne.
Major, John Sigmond Schlundt.[1]
Comptroller, James Pendlebury.
Adjutant, Albrecht Borgard.

1st Company.

Captain, Jonas Watson
Lieutenants:—
1st, Ralph Wood
2nd, Joseph Durden.
Gentlemen of the Ordnance:—
Edward Silvester
Nicholas Whitaker.
Serjeants:—
John Carne
David Thomas.
15 gunners, old establishment:—
Thomas Lincolne
William Topp
Philip Dodwell
William Penny
William Head
True Heart
Thomas Legg
John Colson
Gervis Dewrant
Nicholas Dory
John Ranton
Charles Pickup
Samuel North
John Smithurst
Michael Crofts.
15 gunners, new establishment:—
John Bonamour
Samuel Ball
John Baxter
James Haddock
John Marshall
Thomas Marwood
William Wright
John Milner
John Hirst
Thomas Lunsford
William Morris
John Dale
William Christian
John Charter
Francis Blyton.

2nd Company.

Captain, Edward Gibbon.
Lieutenants:—
1st, Thomas Raskell.
2nd, Andrew Boswell.
Gentlemen of the Ordnance:—
Matthew Purcell
Daniel Cohen (?)
Serjeants:—
John Ellis
Amos Walshaw.
15 gunners, old establishment:—
Joseph Hone
John Bateman
Thomas Taylor
George Guy
George Browne
William Cadogan
Peter Guitchett
Henry Pillar
James Nixon
Thomas Hall

[1] On the 29th November, Major J. H. Hopeke was appointed Major of this train, *vice* Schlundt, resigned.

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James Little
John Burton
Charles Binkley
Philip Spooner
Michael Clarke

15 gunners, new establishment:—
Edward Stevens
John Jordan
John Dobson
John Jeoffries
Leonard Jackson
Thomas Jones
Thomas Serwen
John Nash
Richard Morris
Robert Leslie
John Evans
John Pearne
Thomas Hughes
John Bourden
William Lightfoot.

3rd Company.

Captain, Edward Williamson.

Lieutenants:—
1st, Peter Gilmuyden.
2nd, Edward Glover.

Gentlemen of the Ordnance:—
Christopher Briscoe
Thomas Morris.

Serjeants:—
John Collett | Henry Woodcock.

15 gunners, old establishment:—
John Hollybone
John Roberts
Thomas Maynard
James Murrell
Hermanus Loobeck
Thomas Marsh
Henry Scott
Samuel Clarke
Jeremiah Haughton
Roderick Price
John Thornton
William Charter
Richard Ditchfield
Henry Moore
Nathaniel Hill

15 gunners, new establishment:—
Thomas Wade
Mathew Pybus
Thomas Adams
Edward Norman
David Nicholson
John Tongo
Henry Wooten
Godfrey Franks
Moses Jacock
William Haynes
William Cahoon
Charles Allen
John Hodges
Barnaby Griffith
Jonathan Sanderson

4th Company.

Captain, William Bousfield.

Lieutenants:—
1st, George Brittenstein
2nd, George Spencer

Gentlemen of the Ordnance:—
William Gunn
Robert Welch.

Serjeants:—
Bennet Smith | Edward Rann

15 gunners, old establishment:—
Fenton Field
Daniel Warquin
John Nicholls
John Thomas
William Partridge
Thomas Sealy
Nathaniel Hobbs
Benedict Smith
Thomas Harwood
John Huxford
William Browne
George Fawcett
Edward Wells
John Cartwright
William Wood

15 gunners, new establishment:—
Cadwallader Mashmore
Abraham Carpenter
John Shepheard
Vincent Walker
George Minnens
Thomas Suffolke
David Anderson
Edward Bacchus
Thomas Kectian
Thomas Mitchell
Alexander Mackbridge
Charles Blyton
Nathaniel Norris
John Winch
Francis Moseley

6 engineers (Captains):—
John Manclere
Christian Lilly
Daniel Sherrard
John Hannaway
Isaac Francis Petit
George Conrade Van Cassell

4 sub-engineers:—
Thomas Bell
Benjamin Whithall
Francis Hawkins
Lucas Boitout

2 firemasters (Captains):—
John Lewis Schlundt, chief firemaster,
Robert Guybon [July '97, at £150

12 fireworkers:—
Thomas Newton
Zachariah Smith
Thomas Heydon
Andrew Hideman
William Wilkes
Bryan Ororch
Richard Silver
Thomas Dodge, jun.
John Winskell
Alexander Silver
Joakim Miller | James Finney.

12 Bombardiers:—
Christopher Wells
William Oliver
David Lewis
Moses Baxter
James Griffith
John Speed
John Jones
Edward French
Robert Palmer
Francis Coape
Robert Braman | Alexander Forbes.

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This train of 1698, was reduced on the 31st Jan. 1699, and we find that all the captains, lieutenants, firemasters, fireworkers, and serjeants, comprised in the foregoing list were allowed certain sums in lieu of pay.

Colonel Richards was appointed one of the chief engineers at £150 per annum.

Lieut.-Colonel Browne retained the appointment of Master-gunner of England, to which he succeeded in 1696.

Major Hopeke was appointed chief firemaster, with a salary of £150 per annum.

[*To be Continued.*

NOTE.—It may not be altogether out of place to make a few remarks on the 'nomenclature' of the various species of artillery which are referred to in the foregoing paper. The word *artillery*, is said by Moretii, in his 'Treatise' (translated by Sir Jonas Moore, about 1683), to have been derived from the Italian word *artiglio*, signifying 'the tallons or claws of ravenous fowls, perhaps because its shot flying far off dismembers and tears in pieces all that it meets.' This derivation is probably correct, for we find that the various pieces of artillery have from very early periods been named after birds of prey and venemous serpents; thus, among the field pieces (which were necessarily more moveable than the others) we find the *smeriglio* which is a long-winged hawk; the *falcon*; the *saker* (a species of falcon, and enumerated as such in the catalogue of AUCEPS in 'Walton's *Angler*.') Again, among the heavier and longer pieces, we find the different varieties of the *culvering*, which name is derived from the *colubrine* or *colubrinetta*, a species of serpent: there is also the well-known *cannon serpentine*, as also the *cannon basiliak*. The *bastard* gun was one whose length was less than the *ordinary* of 32 calibres. The *moyenne* or *minion* (of 26 calibres) was a *bastard* piece. Moretii (before quoted) describes also *mortars* or *trabucchi*, 'They are short pieces, of the nature of Petrieroes; and with these they shoot balls of stone, grenado shells, and cases full of small shot, not by a right line, but by a crooked from on high, so they fall where it should be appointed.' . . . . . 'There is no difference betwixt a *mortar* piece and a *trabucchio*, but in the placing of the trunnions.' The *mortar* of the present day is the *trabucchio* referred to, while the ancient *mortar* is something like our 'coehorn howitzer.' The derivation of these names is as follows:—The *trabucchio* is derived from the Italian verb *traboccare*, to throw, or hurl; while the word *mortar* has an evident affinity to the word *morte* 'death,' or *mortorio*, *mortoro*, 'a funeral.'

The following is from the *Orlando Furioso* of Ariosto (circa A.D. 1560), Canto XI. Stanza XXI. et seq.:—

Orlando, I pursue,
That bore Cymasco's thunderbolt away,
And this had in the deepest bottom drowned,
That never more the mischief might be found.

But with small boot: for the impious enemy
Of human nature, taught the *bolt* to frame,
After the *shaft*, which after darting from the sky,
Pierces the cloud, and comes to ground in flame;
Who, when he tempted Eve to eat and die,
With the apple, hardly wrought more scathe and shame—
Some deal before, or on our grandsire's day,
Guided a necromancer where it lay.

More than a hundred fathom buried so,
Where hidden it had lain a mighty space—
The infernal tool by magic from below
Was fished and borne amid the German race,
Who, by one proof and the other, taught to know
Its powers, and he who plots for our disgrace,
The demon, working on their weaker coil,
At last upon its fatal purpose hit.

To Italy and France on every hand
The cruel art among all people past,
And there the bronze in hollow mould expand
First, in the furnace melted by the blast;
Others the iron bore, or small or grand,
Fashion the various tube they pierce or cast,
And *bombard*, *gun*, according to its frame
Or *single cannon* this, or *double* name.

This *Saker*, *Culverine*, or *Falcon* hight,
I hear all names the inventor has bestowed;
Which splits or shivers steel and stone outright,
And where the bullet passes makes a road.
Down to the sword, restore thy weapons bright,
Sad soldier to the forge, a useless load,
And gun or carbine on thy shoulder lay,
Who without these, I wot, shall touch no pay.

ERRATA.

Page 120, line 22, *for* 'and the Royal army,' *read* 'and of the Royal army.'
— 24, *for* 'was,' *read* 'were.'
— 32, *for* 'appears,' *read* 'appear.'

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Experiments on the Strength and Elasticity of Timber, made in the Royal Arsenal, Woolwich, 1852-1859. By Major H. CLERK, R.A., F.R.S.

[Read August 10, 1859].

THE following experiments were commenced in the year 1852, with a view of determining the effect of the desiccating process, by means of hot air, on timber, as compared with that of natural seasoning.

For this purpose six battens of each description of wood used in the Royal Carriage Department were cut to the following dimensions, 5 ft. × 2 in. × 2 in., and carefully weighed. Three of these were desiccated, the other three put away in the seasoning sheds. The desiccated pieces underwent the process from the 29th May to 18th August, 1852, a period of 81 days, when they were again weighed, and one piece of each nature of wood experimented on. The other two were intended to have been tried at periods of six and twelve months after desiccation; but owing to pressure of business on the Department, the second specimens were not tried till April, 1853, and the third till July, 1858, at which time the three natural seasoned specimens were also tried, having had six years to season in. The several pieces were weighed at intervals during the process of seasoning, and their dimensions when broken were taken, in order to ascertain the amount of shrinkage. These are given in Table I.

The amount per cent. of loss in weight and dimension during the process of seasoning is given in Table II.

The experiments on the strength and elasticity were made in a similar manner to those of Professor Barlow, described in his work on "Strength of Timber," &c. and made in the Royal Arsenal in 1832. The dimensions and distance of bearing being the same in both cases, viz. distance of bearing = 50 inches, the battens 2 inches square.

The pieces were loaded in the middle, and supported at both ends. The values of S are calculated by the formula $S = \frac{LW}{4ad^2}$, where L = distance of bearing, W = breaking weight in lbs., a = width, d = depth; these are rather less than 2 inches, owing to the shrinkage in seasoning.

The values of E are calculated by the formula $E = \frac{L^3W}{16ad^3\delta}$, where δ = deflection produced by the weight W. The deflections were observed by means of a vertical screw (of 10 revolutions to the inch) with a micrometer head divided into 100 equal parts; by which means ·001 of an inch could be easily read off. (*Vide* Sketch, Fig. 2).

The specific gravity of each piece was calculated from the dimensions and weight at the time of trial.

Table III. contains the results of the several experiments distinguishing the mean results, of the desiccated from those of the natural seasoned specimens, also the mean result of the two together.

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Table IV. gives a comparison of the values of S and E according as the specimen was desiccated or seasoned by the natural process.

Table V. contains some further experiments on specimens of timber, introduced into the Department since the commencement of the experiments in 1852. None of these were submitted to the desiccating process; also experiments on the transverse strength of cast-iron.

Table VI. is a general abstract of the results of all the experiments, but the values of S and E are for natural seasoned timber only.

Table VII. gives the several descriptions of wood, arranged according to their specific gravity, strength, and elasticity.

Table VIII. contains the weights that iron chain and hempen rope will respectively bear; also the weight of a fathom of each. This Table has been formed from experiments made in H.M. Dockyard, Woolwich, and will be found useful in selecting the most suitable chain or rope for any special purpose.

General Remarks.

It will be seen from Table IV. that the sum of all the values of E by the natural seasoning process or ΣE is 9696600, and that the sum of the differences between the desiccated and natural process or $\Sigma\delta E$ is $-$ 859200; therefore

$$\frac{\Sigma\delta E}{\Sigma E} = -\frac{859200}{9696600} = -\cdot089,$$

or the average loss of elasticity by the desiccating process amounts to nearly one-tenth of the natural value.

Also that the sum of all the values of S by the natural process or $\Sigma S = 42093$, and the sum of the differences or $\Sigma\delta S = +794$; therefore

$$\frac{\Sigma\delta S}{\Sigma S} = +\frac{794}{42093} = +\cdot019.$$

This apparent increase of strength is probably caused by variations in the quality of the specimens, and not by the desiccating process.

There can be no doubt, from these experiments, that the desiccating process has an injurious effect upon wood, rendering it very brittle. When elasticity, therefore, is required, for ash handspikes and shafts, for instance, this process should not be resorted to; if time cannot be allowed for natural seasoning, then steaming is preferable to desiccation. When toughness only is required, for elm brackets for instance, there is not so great an objection, and it is better to desiccate than to use wood not thoroughly dry.

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TABLE I.

WEIGHTS AND DIMENSIONS OF THE SEVERAL PIECES OF WOOD AT DIFFERENT PERIODS DURING THE PROCESS OF SEASONING.

Name of Wood.	No. of Piece.	How Seasoned.	Weights at different periods.						Loss in Seasoning.	Dimensions when broken.	
			When Green.	After Desiccation.	6 months after.	12 months after.	5 years after.	6 years after.		Breadth.	Depth.
			oz.	oz.	oz.	oz.	oz.	oz.	oz.	in.	in.
Acacia, (English).	1	Desiccated	117·3	85·3	...	...	...	...	32·0	1·88	1·94
	2		120·3	88·8	...	...	...	...	31·5	1·94	1·96
	3		124·3	88·8	...	...	...	...	35·5	1·90	1·93
	4	Nat. Season	118·8	...	...	88·0	85·8	85·3	33·5	1·89	1·95
	5		121·8	...	...	107·3	95·0	91·0	30·8	1·93	1·96
	6		123·3	...	...	90·5	88·8	87·0	36·3	1·88	1·95
Ash, (English).	7	Desiccated	112·5	92·0	...	...	...	...	20·5	1·88	1·90
	8		114·5	91·8	...	...	...	...	22·7	1·88	1·93
	9		109·3	87·0	...	...	...	...	22·3	1·90	1·90
	10	Nat. Season	112·8	...	...	98·3	96·0	94·3	18·5	1·88	1·91
	11		111·3	...	...	93·0	90·3	90·0	21·3	1·90	1·95
	12		109·3	...	...	90·3	88·0	87·5	21·8	1·90	1·95
Beech, (English).	13	Desiccated	104·0	101·3	...	...	...	...	2·7	1·81	1·94
	14		103·3	83·8	84·0	...	...	...	17·3	1·84	1·96
	15		110·8	105·0	105·5	107·0	107·5	105·3	5·5	1·98	1·98
	16	Nat. Season	102·3	...	...	87·3	85·5	84·3	18·0	1·85	1·95
	17		103·3	...	...	89·0	84·0	86·5	16·8	1·88	1·94
	18		111·3	...	...	110·5	108·8	108·0	3·3	1·95	2·00
Elm, (English).	1	Desiccated	87·0	72·3	...	...	...	...	14·7	1·94	1·95
	2		86·5	74·5	74·5	...	...	...	12·0	1·92	1·92
	3		130·8	76·8	74·5	75·5	75·5	74·3	56·5	1·90	1·90
	4	Nat. Season	88·3	...	...	77·5	76·5	74·3	14·0	1·93	1·95
	5		80·3	...	...	74·0	72·3	73·3	7·0	1·93	1·90
	6		143·8	...	...	79·8	78·3	76·0	67·8	1·95	1·95
Hornbeam, (English).	1	Desiccated	127·8	96·5	...	...	...	...	31·3	1·89	1·90
	2		129·0	97·0	97·0	...	...	...	32·0	1·82	1·95
	3		130·5	97·0	96·0	97·7	96·0	96·5	34·0	1·83	1·90
	4	Nat. Season	129·0	...	...	102·8	100·5	99·0	30·0	1·90	1·90
	5		131·8	...	...	105·8	103·0	101·5	30·3	1·89	1·96
	6		126·0	...	...	101·5	99·3	97·0	29·0	1·88	1·94
Oak, (English).	1	Desiccated	132·0	96·8	...	...	...	...	35·2	1·91	1·93
	2		131·3	95·3	95·3	...	...	...	36·0	1·92	1·92
	3		128·8	94·8	94·8	95·7	95·5	95·0	33·8	1·90	1·95
	4	Nat. Season	133·9	...	...	102·3	99·8	99·0	34·9	1·95	2·00
	5		129·6	...	...	101·3	98·3	97·0	32·6	1·93	1·93
	6		126·3	...	...	100·3	98·0	96·3	30·3	1·93	1·94
Oak, (African).	1	Desiccated	123·3	112·8	...	...	...	...	10·5	1·95	1·96
	2		132·8	122·3	125·0	...	...	...	7·8	2·00	2·00
	3		134·3	123·5	126·8	126·3	125·3	124·3	10·0	1·93	1·90
	4	Nat. Season	118·0	...	...	114·5	111·0	109·7	8·3	1·91	1·93
	5		123·3	...	...	116·8	113·3	112·3	11·0	1·93	1·89
	6		124·5	...	...	119·8	115·8	114·3	10·2	1·93	1·93
Cedar, (Havannah).	1	Desiccated	66·5	55·0	...	...	...	...	11·5	1·96	1·98
	2		64·3	55·3	56·3	...	...	...	8·0	2·00	2·00
	3		63·3	54·5	56·0	55·5	54·5	54·0	9·3	1·98	1·95
	4	Nat. Season	60·8	...	...	55·8	53·5	53·3	7·5	1·94	1·94
	5		63·8	...	...	57·3	55·5	55·0	8·8	1·98	1·98
	6		62·0	...	...	58·3	55·8	55·5	6·5	1·98	1·98

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TABLE I.—*Continued.*

Name of Wood.	No. of Piece.	How Seasoned.	Weights at different periods.						Loss in seasoning.	Dimensions when broken.	
			When Green.	After Desiccation.	6 months after.	12 months after.	5 years after.	6 years after.		*a.* Breadth.	*d.* Depth.
			oz.	oz.	oz.	oz.	oz.	oz.	oz.	in.	in.
Fir, (American Yellow Pine).	1	Desiccated	71·3	55·3	...	...	...	...	16·0	1·94	1·98
	2		74·8	57·8	59·3	...	...	...	15·5	2·00	2·00
	*3										
	4	Nat. Season	69·8	...	...	58·3	56·5	56·0	13·8	1·94	1·95
	5		61·3	...	...	54·3	54·0	53·5	7·8	1·98	1·98
	6		87·0	...	...	60·8	59·0	58·3	28·7	1·95	1·96
Fir, (Petersburgh).	7	Desiccated	93·5	88·0	...	...	...	...	5·5	1·98	2·00
	8		95·5	89·3	91·5	...	...	...	4·0	2·00	2·00
	9		79·5	76·0	78·0	77·5	77·0	76·0	3·5	1·94	1·96
	10	Nat. Season	88·5	...	...	87·8	86·5	85·7	2·8	1·93	1·98
	11		85·5	...	...	84·3	83·5	82·3	3·2	1·96	1·99
	12		72·8	...	...	71·0	70·8	70·0	2·8	1·95	1·95
Fir, (Dantzic).	13	Desiccated	77·5	75·0	...	...	...	...	2·5	1·94	1·95
	14		71·5	58·8	60·3	...	...	...	11·2	1·92	1·98
	15		69·5	66·5	68·3	67·7	...	67·7	1·8	1·95	1·99
	16	Nat. Season	72·0	...	...	70·8	69·5	68·7	3·3	1·99	1·98
	17		73·0	...	...	61·3	60·3	59·7	13·3	1·95	1·91
	18		68·0	...	...	64·8	63·3	62·7	5·3	1·88	1·93
Mahogany, (Spanish).	1	Desiccated	125·5	109·0	...	...	...	...	16·5	2·00	2·00
	2		121·3	107·8	109·5	...	...	...	11·8	2·00	2·00
	3		125·5	112·5	114·5	114·3	113·8	113·0	12·5	1·99	1·99
	4	Nat. Season	114·8	...	...	110·5	108·8	107·7	7·1	2·00	1·99
	5		121·5	...	...	111·5	109·0	108·5	13·0	1·96	1·96
	6		123·5	...	...	123·0	120·5	120·3	3·2	2·00	2·00
Mahogany, (Honduras).	1	Desiccated	88·8	74·0	...	...	...	...	14·8	1·94	1·95
	2		81·8	70·8	72·5	...	...	...	9·3	2·00	2·00
	3		81·5	67·3	69·3	69·0	68·3	68·0	13·5	1·95	1·93
	4	Nat. Season	84·0	...	...	72·5	70·8	70·3	13·7	1·95	1·95
	5		83·3	...	...	73·3	71·0	70·0	13·3	1·99	1·98
	6		82·0	...	...	71·3	69·0	68·5	13·5	1·96	1·96
Mahogany, (African).	1	Desiccated	123·8	106·3	...	...	...	...	17·5	1·93	1·95
	2		127·8	103·8	106·0	...	...	...	21·8	1·92	1·98
	3		134·0	113·3	115·8	115·5	114·5	114·0	20·0	1·98	1·95
	4	Nat. Season	135·0	...	...	117·3	114·5	114·0	21·0	1·95	1·98
	5		133·5	...	...	116·8	113·0	113·0	20·5	1·98	1·98
	6		137·3	...	...	116·8	113·8	113·3	24·0	2·00	1·99
Pedook, (E. India).	1	Desiccated	155·8	135·0	...	...	...	...	20·8	1·95	1·98
	2		159·5	133·3	134·3	...	...	...	25.2	1·98	1·98
	3		161·5	137·5	138·5	138·3	138·0	137·0	24·5	1·99	1·99
	4	Nat. Season	158·5	...	...	139·3	136·0	134·5	24·0	1·96	1·96
	5		166·3	...	...	143·5	140·0	139·5	26·8	1·96	1·96
	6		162·0	...	...	140·3	136·5	136·0	26·0	1·98	1·98
Sabicu, (Cuba).	1	Desiccated	156·5	117·3	...	...	...	...	39·2	2·00	2·00
	2		148·3	115·0	116·5	...	...	...	31·8	2·00	2·00
	3		147·3	116·8	117·8	117·5	117·3	115·7	31·6	1·98	1·98
	4	Nat. Season	131·8	...	...	125·8	118·3	116·7	15·1	1·95	1·95
	5		143·8	...	...	130·5	122·3	121·0	22·8	2·00	2·00
	6		138·5	...	...	129·0	119·3	119·0	19·5	1·98	2·00

* No. 3 piece of American Fir was mislaid.

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TABLE I.—*Continued.*

Name of Wood.	No. of Piece.	How Seasoned.	Weights at different periods.						Loss in Seasoning.	Dimensions when broken.	
			When Green.	After Desiccation.	6 months after.	12 months after.	5 years after.	6 years after.		a. Breadth.	d. Depth.
			oz.	oz.	oz.	oz.	oz.	oz.	oz.	in.	in.
Teak, (Moulmein).	1	Desiccated	113·5	94·5	...	...	...	...	19·0	2·00	2·00
	2	Desiccated	124·8	92·5	94·0	...	...	...	30·8	2·00	2·00
	3	Desiccated	122·8	95·5	96·8	96·3	95·0	95·0	27·8	1·96	1·98
	4	Nat. Season	115·5	...	...	95·3	93·8	93·3	18·2	1·95	1·95
	5	Nat. Season	116·3	...	...	97·8	96·3	95·5	20·8	2·00	2·00
	6	Nat. Season	113·8	...	...	95·8	93·5	93·0	20·8	1·99	2·00
Wainscot, (Riga).	7	Desiccated	116·5	80·5	...	...	...	...	36·0	1·95	1·95
	8	Desiccated	110·3	75·5	76·8	...	...	...	33·5	1·92	1·98
	9	Desiccated	112·8	72·5	74·3	74·0	73·5	73·0	39·8	1·98	1·95
	10	Nat. Season	117·5	...	...	80·3	78·8	77·3	40·2	1·98	1·95
	11	Nat. Season	112·3	...	...	78·0	76·3	75·5	36·8	1·99	1·95
	12	Nat. Season	117·8	...	...	81·3	79·3	78·7	39·1	1·99	1·95

TABLE II.

SHEWING THE LOSS PER CENT. IN WEIGHT, AND CONTENT OF EACH DESCRIPTION OF TIMBER, DURING THE PROCESS OF SEASONING.

Name of Wood.	Loss per cent in weight.	Loss per cent in content.	Name of Wood.	Loss per cent in weight.	Loss per cent in content.
	oz.	inch.		oz.	inch.
Acacia ..... (English).	27·50	7·292	Fir ..... Petersburgh.	4·23	2·979
Ash ..... do.	18·98	9·125	do. ..... Dantzic.	8·67	5·181
Beech..... do.	10·02	7·556	Mahogany... Spanish.	8·76	0·917
Elm ..... do.	13·94	7·042	do. ..... Honduras.	15·58	3·632
do. fresh cut do.	45·27		do. ..... African.	15·77	3·389
Hornbeam... do.	24·11	10·084	Pedook ..... E. India.	15·29	2·729
Oak ..... do.	25·94	6·479	Sabicu ..... Cuba.	18·47	1·326
do. ..... African.	7·64	6·069	Teak ..... Moulmein.	19·55	1·410
Cedar ..... Havannah.	13·55	2·736	Wainscot ... Riga.	32·80	3·799
Fir ..... American.	24·91	3·372	Iron-Bark... Australia.	8·58	3·723

Remarks.

The pieces of Elm Nos. 3 and 6, were cut from a tree newly felled in the Arsenal, and were full of sap. The pieces of Beech were from plank which had been cut from logs felled about twelve months previously; the rest of the English timber had been felled about six months. The Foreign timber was all about two years old, and partially seasoned.

The Iron Bark did not form part of the original series. Its weight when green was 170·1 oz., and when seasoned 155·5 oz., and the dimensions were reduced to 1·95″ × 1·98″ from 2″ × 2″.

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TABLE III.

EXPERIMENTS ON THE ELASTICITY AND STRENGTH OF VARIOUS DESCRIPTIONS OF TIMBER; SOME DESICCATED, OTHERS SEASONED NATURALLY.

Name of Wood.	No. of Piece.	Specific Gravity.	Deflection and Weight.		Breaking Weight.	Ultimate Deflection.	Value of *E*.	Value of *S*.	Mean Value.		Remarks.
			Weight.	Deflection.					*E*.	*S*.	
			lbs.	in.	lbs.	in.					
Acacia, (English).	1	676	336	0·681	1008	2·854	282400	1789	285300	1775	Desiccated.
	2	672	336	0·625	1029	3·000	287000	1724			
	3	699	336	0·676	1021	3·222	286500	1813			
	4	667	336	0·568	1176	3·820	329800	2046	321400	1900	Nat. Season.
	5	693	336	0·552	1121	5·400	327200	1890			
	6	684	336	0·613	1008	2·400	307200	1763			
Mean Results		682	336	0·619	1061	3·449	303400	1838			
Ash, (English).	7	744	336	0·429	1311	4·047	475800	2421	439500	2243	Desiccated.
	8	730	336	0·485	1210	3·338	404700	2177			
	9	694	336	0·460	1169	3·509	437900	2131			
	10	756	336	0·342	1505	3·480	586000	2743	463400	2314	Nat. Season.
	11	700	336	0·438	1252	4·700	425400	2166			
	12	680	336	0·492	1175	3·983	378700	2033			
Mean Results		718	336	0·441	1270	3·843	451400	2279			
Beech, (English).	13	830	336	0·533	1288	2·625	373400	2366	464000	2414	Desiccated.
	14	671	336	0·436	1378	2·844	434600	2437			
	15	774	336	0·299	1514	2·770	583900	2438			
	16	673	336	0·363	1262	2·630	527200	2242	530700	2416	Nat. Season.
	17	683	336	0·378	1383	2·700	505900	2444			
	18	798	336	0·301	1598	3·450	559000	2561			
Mean Results		738	336	0·385	1404	2·837	497400	2415			
Elm, (English).	1	551	336	0·691	966	3·127	283300	1639	273800	1666	Desiccated.
	2	582	336	0·687	1036	3·810	281200	1830			
	3	593	336	0·784	840	3·718	256900	1531			
	4	569	336	0·692	840	2·500	265100	1431	299600	1530	Nat. Season.
	5	576	336	0·681	896	3·120	291200	1608			
	6	576	336	0·530	919	5·270	342600	1550			
Mean Results		575	336	0·678	916	3·491	286700	1598			
Hornbeam, (English).	1	775	336	0·532	1383	3·677	381000	2536	445100	2586	Desiccated.
	2	787	336	0·399	1568	3·187	487500	2832			
	3	800	336	0·448	1263	4·100	466800	2390			
	4	790	336	0·310	1363	3·500	649800	2484	569400	2466	Nat. Season.
	5	789	336	0·329	1400	3·100	560600	2410			
	6	766	336	0·393	1418	3·053	497900	2505			
Mean Results		785	336	0·402	1399	3·436	507300	2528			
Oak, (English).	1	757	336	0·607	1376	3·773	316900	2427	369300	2180	Desiccated.
	2	744	336	0·457	1232	2·674	422700	2176			
	3	739	336	0·506	1120	2·555	368300	1938			
	4	731	336	0·413	1176	2·570	407400	1885	398500	1977	Nat. Season.
	5	750	336	0·533	1141.	2·855	354900	1984			
	6	741	336	0·430	1199	2·840	433200	2063			
Mean Results		744	336	0·491	1207	2·878	383900	2079			
Oak, (African).	1	848	336	0·344	1904	2·504	517300	3167	609200	2952	Desiccated.
	2	900	336	0·234	1904	1·853	701100	2975			
	3*	976	336	0·092	1512	1·300	2155500	2713			
	4	857	336	0·281	1884	2·833	680300	3310	711900	3151	Nat. Season.
	5	887	336	0·266	1614	2·670	757400	2926			
	6	884	336	0·271	1851	2·346	698100	3218			
Mean Results		892	336	0·279	1778	2·441	660600	3052			

* The Deflections of No. 3 piece of African Oak have not been included in the mean, as they are evidently erroneous. The piece was defective, and broke suddenly at a worm-hole.

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TABLE III.—*Continued.*

Name of Wood.	No. of Piece.	Specific Gravity.	Deflection and Weight.		Breaking Weight.	Ultimate Deflection.	Value of *E*.	Value of *S*.	Mean Value		Remarks.
			Weight.	Deflection.					*E*.	*S*.	
			lbs.	in.	lbs.	in.					
Cedar, (Havannah).	1	409	336	0·772	784	2·145	224900	1280	268200	1193	Desiccated.
	2	405	336	0·571	728	1·915	287300	1138			
	3	403	336	0·611	700	2·130	292600	1162			
	4	408	336	0·853	658	2·042	217300	1127	257200	1138	Nat. Season.
	5	404	336	0·581	728	2·016	293900	1172			
	6	408	336	0·656	693	1·917	260400	1116			
Mean Results		406	336	0·674	715	2·028	262700	1166			
Fir, (American).	1	416	336	0·598	896	1·757	294000	1482	325000	1354	Desiccated.
	2	428	336	0·461	784	1·057	355900	1225			
	4	426	336	0·403	885	1·720	452800	1500	450100	1520	Nat. Season.
	5	397	336	0·443	882	2·205	389500	1435			
	6	439	336	0·352	974	1·718	507900	1625			
Mean Results		421	336	0·451	884	1·691	400000	1453			
Fir, (Petersburgh).	7	642	336	0·320	1344	1·700	519200	2127	566700	2023	Desiccated.
	8	659	336	0·328	1260	1·824	500200	1969			
	9	576	336	0·264	1176	1·876	680700	1972			
	10	646	336	0·276	1232	1·622	634800	2035	620700	1859	Nat. Season.
	11	608	336	0·275	1086	1·482	618000	1749			
	12	530	336	0·298	1064	1·767	609200	1794			
Mean Results		610	336	0·294	1194	1·712	593700	1941			
Fir, (Dantsic).	13	572	336	0·485	1094	2·043	376700	1856	450800	1650	Desiccated.
	14	458	336	0·371	896	1·855	474700	1488			
	15	503	336	0·341	992	2·031	501000	1606			
	16	502	336	0·294	1092	2·378	578000	1750	534300	1659	Nat. Season.
	17	462	336	0·376	925	2·500	513800	1626			
	18	498	336	0·380	896	2·240	511100	1600			
Mean Resulst		499	336	0·375	983	2·175	492600	1655			
Mahogany, (Spanish)	1	785	336	0·375	1288	1·590	437500	2013	459300	2144	Desiccated.
	2	788	336	0·341	1456	1·699	481100	2275			
	4	779	336	0·336	1285	1·611	495700	2028	488900	2127	Nat. Season.
	5	813	336	0·369	1341	1·835	482000	2226			
Mean Results		792	336	0·355	1343	1·684	474100	2136			
Mahogany, (Honduras).	1	564	336	0·545	1232	2·806	343000	2090	350900	1874	Desiccated.
	2	522	336	0·510	1120	2·317	321700	1750			
	3	520	336	0·483	1036	2·435	387700	1783			
	4	533	336	0·526	1050	2·347	345200	1770	347600	1701	Nat. Season.
	5	512	336	0·508	1008	2·027	334500	1615			
	6	514	336	0·490	1035	2·170	363000	1718			
Mean Results		528	336	0·510	1090	2·350	349200	1788			
Mahogany, (African).	1	815	336	0·377	1456	1·955	487800	2496	488500	2245	Desiccated.
	2	803	336	0·424	1120	1·806	415400	1860			
	3	850	336	0·318	1439	2·015	562300	2389			
	4	850	336	0·312	1456	1·855	555800	2381	509600	2371	Nat. Season.
	5	830	336	0·372	1512	2·307	459100	2435			
	6	820	336	0·324	1456	1·920	514000	2298			
Mean Results		828	336	0·355	1407	1·976	499200	2308			
Pedook, (E. India).	1	1009	336	0·241	2576	2·395	725000	4233	788400	4211	Desiccated.
	2	987	336	0·244	2576	2·050	699800	4148			
	3	996	336	0·178	2691	2·160	940400	4253			
	4	1008	336	0·221	2240	1·840	804800	3719	860600	3905	Nat. Season.
	5	1046	336	0·186	2464	1·976	956300	4090			
Mean Results		1009	336	0·214	2507	2·084	825300	4089			

Note.—Nos. 3 and 6 of Spanish Mahogany, and No. 6 of Pedook, were defective, their results have not been included. No. 3 of American Fir was mislaid.

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TABLE III.—*Continued.*

Name of Wood.	No. of Piece.	Specific Gravity.	Deflection and Weight. Weight.	Deflection and Weight. Deflection.	Breaking Weight.	Ultimate Deflection.	Value of *E*.	Value of *S*.	Mean Value *E*.	Mean Value *S*.	Remarks.
			lbs.	in	lbs.	in.					
Sabicu, (Cuba).	1	844	336	0·356	1792	2·176	460800	2800	499200	2730	Desiccated.
	2	839	336	0·324	1834	2·294	506400	2866			
	3	863	336	0·322	1568	1·666	530400	2525			
	4	884	336	0·346	1841	2·680	524700	3104	530200	2940	Nat. Season.
	5	871	336	0·285	1785	2·208	575700	2789			
	6	865	336	0·338	1855	2·500	490300	2928			
Mean Results		861	336	0·329	1779	2·254	514700	2835			
Teak, (Moulmein).	1	680	336	0·308	1775	2·059	532700	2773	571400	2804	Desiccated.
	2	677	336	0·305	1808	2·193	537900	2825			
	3	705	336	0·268	1729	1·830	643800	2813			
	4	707	336	0·298	1428	1·826	609200	2408	575400	2512	Nat. Season.
	5	688	336	0·307	1610	1·876	534400	2516			
	6	673	336	0·283	1663	2·030	582700	2612			
Mean Results		688	336	0·295	1669	1·969	573400	2658			
Wainscot, (Riga).	7	610	336	0·580	1050	2·417	313000	1770	263800	1427	Desiccated.
	8	582	336	0·724	840	2·114	243300	1395			
	9	545	336	0·761	672	1·827	235000	1116			
	10	577	336	0·788	623	1·747	226900	1034	261300	1154	Nat. Season.
	11	560	336	0·617	777	1·863	288300	1283			
	12	584	336	0·662	693	1·547	268700	1145			
Mean Results		572	336	0·699	776	1·919	262600	1291			
Iron-Bark, (Australia).	1	1150	336	0·193	2333	2·473	871900	3739	919100	3416	Desiccated.
	2	1140	336	0·197	1988	1·845	841200	3138			
	3	1178	336	0·173	2009	1·594	1044100	3370			
	4	1164	336	0·186	2175	2·079	945800	3556	945800	3453	Nat. Season.
	5	1161	336	0·167	2224	1·911	1038400	3636			
	6	1176	336	0·215	1831	1·587	866700	3168			
Mean Results		1163	336	0·189	2093	1·915	932500	3435			

TABLE IV.

COMPARISON OF THE VALUES OF *E* AND *S*, ACCORDING AS THE TIMBER IS DESICCATED OR DRIED BY NATURAL SEASONING.

Name of Wood.	Desiccated. *E*.	Desiccated. *S*.	Natural Season. *E*.	Natural Season. *S*.	Difference. *E*. —	Difference. *E*. +	Difference. *S*. —	Difference. *S*. +
Acacia ..... English.	285300	1775	321400	1900	36100	...	125	...
Ash ..... do.	439500	2243	463400	2314	23900	...	71	...
Beech..... do.	464000	2414	530700	2416	66700	...	2	...
Elm ..... do.	273800	1666	299600	1530	25800	...	...	136
Hornbeam... do.	445100	2586	569400	2466	124300	...	...	120
Oak ..... do.	369300	2180	398500	1977	29200	...	...	203
do. ..... African.	609200	2952	711900	3151	102700	...	199	...
Cedar..... Havannah.	268200	1193	257200	1138	...	11000	...	55
Fir ..... American.	325000	1354	450100	1520	125100	...	166	...
do..... Petersburgh.	566700	2023	620700	1859	54000	...	...	164
do..... Dantzic.	450800	1650	534300	1659	83500	...	9	...
Mahogany.. Spanish.	459300	2144	488900	2127	29600	...	...	17
do. ..... Honduras.	350800	1874	347600	1701	...	3200	...	173
do. ..... African.	488500	2245	509600	2371	21100	...	126	...
Pendook ..... E. India.	788400	4211	880600	3905	92200	...	...	306
Sabicu ..... Cuba.	499200	2730	530200	2940	31000	...	210	...
Teak ..... Moulmein.	571400	2804	575400	2512	4000	...	...	292
Wainscot ... Riga.	263800	1427	261300	1154	...	2500	...	273
Iron Bark.. Australian.	919100	3416	945800	3453	26700	...	37	...
Note. — Sign denotes that the Desiccated is the lowest.		Sums	9696600	42093	875900	16700	945	1739
					— 859200		+ 794	

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TABLE V.

ADDITIONAL EXPERIMENTS ON THE STRENGTH, ETC. OF TIMBER.

(Distance of Bearings = 50 inches).

Name of Wood.	No. of Piece.	Weight.	Dimensions $l = 60''$		Specific Gravity.	Deflection and Weight.		Breaking Weight.	Ultimate Deflection.	Values of		Remarks.
			a.	*d.*		Weight.	Deflection.			*E.*	*S.*	
		oz.	in.	in.		lbs.	in.	lbs.	in.			
Sweet Chesnut, (English).	1	102·3	2·0	2·0	734	336	0·447	1106	3·140	367000	1728	Dried in Engine room; ¼ds dry.
Greenheart, (W. India).	1	149·3	1·98	2·00	1086	336	0·145	2490	2·423	1143900	3940	Natural Season about 2 years; ¼ds dry.
	2	151·7	2·00	1 99	1093	336	0·161	2685	2·320	1034500	4238	
	3	152·3	2·00	2·00	1096	336	0·164	2632	2·222	1000400	4113	
Mean Results		151·1	1·99	2·00	1093	336	0·157	2602	2·322	1059600	4097	
Mahogany, (Mexican).	1	81·7	2·00	2·00	588	336	0·520	840	1·800	315500	1313	About 2 years old; ¼ds dry.
	2	70·3	2·00	1·99	509	336	0·513	921	2·580	324700	1454	
	3	81·5	1·98	2·00	593	336	0·543	949	2·710	305200	1498	
Mean Results		77·8	1·99	2·00	563	336	0·525	903	2·357	315100	1422	
Mahogany, (Porto Rico).	1	134·3	1·96	1·98	997	336	0·328	1526	2·180	526000	2482	About 2 years old; ¼ds dry.
	2	132·7	2·00	2.00	955	336	0·319	1355	2·390	514300	2117	
	3	127·7	1·99	2·00	924	336	0·267	1525	2·428	603500	2395	
Mean Results		131·6	1·98	1·99	959	336	0·305	1469	2·333	547900	2331	
Pitch Pine, (American).	1	90·5	2·0	2·0	651	336	0·293	1120	2·123	559600	1750	About 2 years old; ¼ds dry; A good Specimen.
	2	96·3	2·0	2·0	693	336	0·305	1120	2·112	537900	1750	
	3	100·3	2·0	2·0	722	336	0·242	1208	2·505	677900	1888	
Mean Results		95·7	2·0	2·0	689	336	0·280	1149	2·247	591900	1798	
Walnut, (Spanish).	1	85·7	1·90	1·85	702	336	0.787	1110	6·520	277300	2134	About 3 years old; ¼ds dry; very crooked grained.
	2	85·0	1·88	1·93	675	336	0·593	1411	4·717	327500	2519	
	3	91·3	1·90	1·95	710	336	0·718	1309	5·730	259500	2265	
Mean Results		87·3	1·89	1·91	696	336	0·699	1277	5·656	288100	2306	
Walnut, black (American).	1	68·7	1·95	1·95	520	336	0·491	1103	2·446	369800	1860	About 2 years old; ¼ds dry; very straight grained.
	2	76·5	1·94	1·96	579	336	0·377	1344	2·750	476700	2254	
	3	73·7	1·95	1·98	550	336	0·434	1183	2·350	399600	1934	
Mean Results		73·0	1·95	1·96	550	336	0·434	1210	2·515	415400	2016	
Cast Iron.	7	242·	0·99	0·99	7111	336	0·462	623	1·130	5915000	8044	Cast horizontally.
	8	241·	0·99	0·99	7082	336	0·628	459	0·950	4351000	5913	
	9	235·	0·95	0·98	7270	336	0·610	649	1·435	4813000	8891	
	10	229	0·93	0·93	7626	336	0·648	501	1·083	5415000	7786	Cast vertically.
	11	239	0·95	0·95	7986	336	0·622	543	1·173	5182000	7917	
	12	236	0·93	0·95	7693	336	0·701	508	1·163	4696000	7566	
Mean Results		237	0·96	0·97	7461	336	0·612	547	1·156	5062000	7686	

Note.—The specimens of cast-iron all broke with a clean fracture, except No. 8, which was slightly defective. The iron was a mixture of Common Scrap and Scotch Pig, No. 1, in the proportion of 2 of the former to 3 of the latter.

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TABLE VI.

ABSTRACT OF EXPERIMENTS.

Name of Wood.	Specific Gravity.	Ultimate Deflection.	Value of *S*.	Value of *E*.	Remarks.
		inches.			
Acacia ..... English.	682	3·449	1900	321400	Dimensions 2″ × 2″.
Ash ..... do.	718	3·843	2314	463400	Very superior quality.
Beech..... do.	738	2·837	2416	530700	Very fine specimens.
Elm ..... do.	575	3·491	1530	299600	Quality good.
Hornbeam ..... do.	785	3·436	2466	569400	A fair specimen.
Oak ..... do.	744	2·878	1977	398500	Quality good, but cross grained.
do. ..... African.	892	2·441	3151	711900	Good specimen.
Cedar..... Havannah.	406	2·028	1138	257200	do.
Fir ..... American.	421	1·691	1520	450100	do.
do. ..... Petersburgh.	610	1·712	1859	620700	do.
do. ..... Dantzic.	499	2·175	1659	534300	do.
Mahogany ..... Spanish.	792	1·684	2127	488900	do.
do. ..... Honduras.	528	2·350	1701	347600	A fair sample.
do. ..... African.	828	1·976	2371	509600	A good specimen.
do. ..... Mexican.	563	2·357	1422	315100	Very good specimen.
do. ..... Porto Rico.	959	2·333	2331	547900	Rather cross grained, mottled.
Pedook ..... East India.	1009	2·084	3905	880600	Very good.
Pitch Pine ..... American.	689	2·247	1796	591900	Fair specimens.
Sabicu ..... Cuba.	861	2·254	2940	530200	Very good.
Sweet Chesnut. English.	734	3·140	1728	367000	Cut from a small tree.
Iron Bark..... Australia.	1163	1·915	3453	945800	Very good specimen.
Greenheart ... West India.	1093	2·322	4097	1059600	A good specimen.
Teak ..... Moulmein.	688	1·969	2512	575400	Good quality.
Wainscot ..... Riga.	572	1·919	1154	261300	do.
Walnut..... Spanish.	696	5·656	2306	288100	Very crooked grained.
do. (black). ... American.	550	2·515	2016	415400	Very fine specimens.
Cast-iron	7461	1·156	7686	5062000	Dimensions 1″ × 1″.

TABLE VII.

DIFFERENT DESCRIPTIONS OF TIMBER, ARRANGED ACCORDING TO THEIR SPECIFIC GRAVITY, STRENGTH, AND ELASTICITY.

Specific Gravity.		Strength.		Elasticity.	
Name of Wood.	Gravity.	Name of Wood.	*S*.	Name of Wood.	*E*.
Iron Bark.....	1163	Greenheart	4097	Greenheart	1059600
Greenheart	1093	Pedook	3905	Iron Bark.....	945800
Pedook	1009	Iron-Bark.....	3453	Pedook	880600
Mahogany (Porto Rico)	959	African Oak.....	3151	African Oak.....	711900
African Oak	892	Sabicu	2940	Fir (Petersburgh)	620700
Sabicu	861	Teak	2512	Pitch Pine	591900
Mahogany (African) ...	828	Hornbeam.....	2466	Teak	575400
do. (Spanish) ...	792	Beech.....	2416	Hornbeam.....	569400
Hornbeam.....	785	Mahogany (African) ...	2371	Mahogany (Porto Rico)	547900
Oak (English)	744	do. (Porto Rico)	2331	Fir (Dantzic)	534300
Beech.....	738	Ash.....	2314	Beech.....	530700
Chesnut E.	734	Walnut (Spanish)	2306	Sabicu	530200
Ash.....	718	Mahogany (Spanish) ...	2127	Mahogany (African) ...	509600
Walnut (Spanish)	696	Walnut (American) ...	2016	do. (Spanish) ...	488900
Pitch Pine.....	689	Oak (English)	1977	Ash.....	463400
Teak (Moulmein)	688	Acacia	1900	Fir (American)	450100
Acacia	682	Fir (Petersburgh)	1859	Walnut (American) ...	415400
Fir (Petersburgh)	610	Pitch Pine	1796	Oak (English)	398500
Elm.....	575	Chesnut E.	1728	Chesnut E.	367000
Wainscot (Riga).....	572	Mahogany (Honduras)	1701	Mahogany (Honduras)	347600
Mahogany (Mexican)...	563	Fir (Dantzic)	1659	Acacia	321400
Walnut (American) ...	550	Elm.....	1530	Mahogany (Mexican)...	315100
Mahogany (Honduras)	528	Fir (American)	1520	Elm.....	299600
Fir (Dantzic)	499	Mahogany (Mexican)...	1422	Walnut (Spanish)	288100
Fir (American)	421	Wainscot (Riga).....	1154	Wainscot (Riga).....	261300
Cedar (Havannah).....	406	Cedar.....	1138	Cedar.....	257200

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Fig. 1.

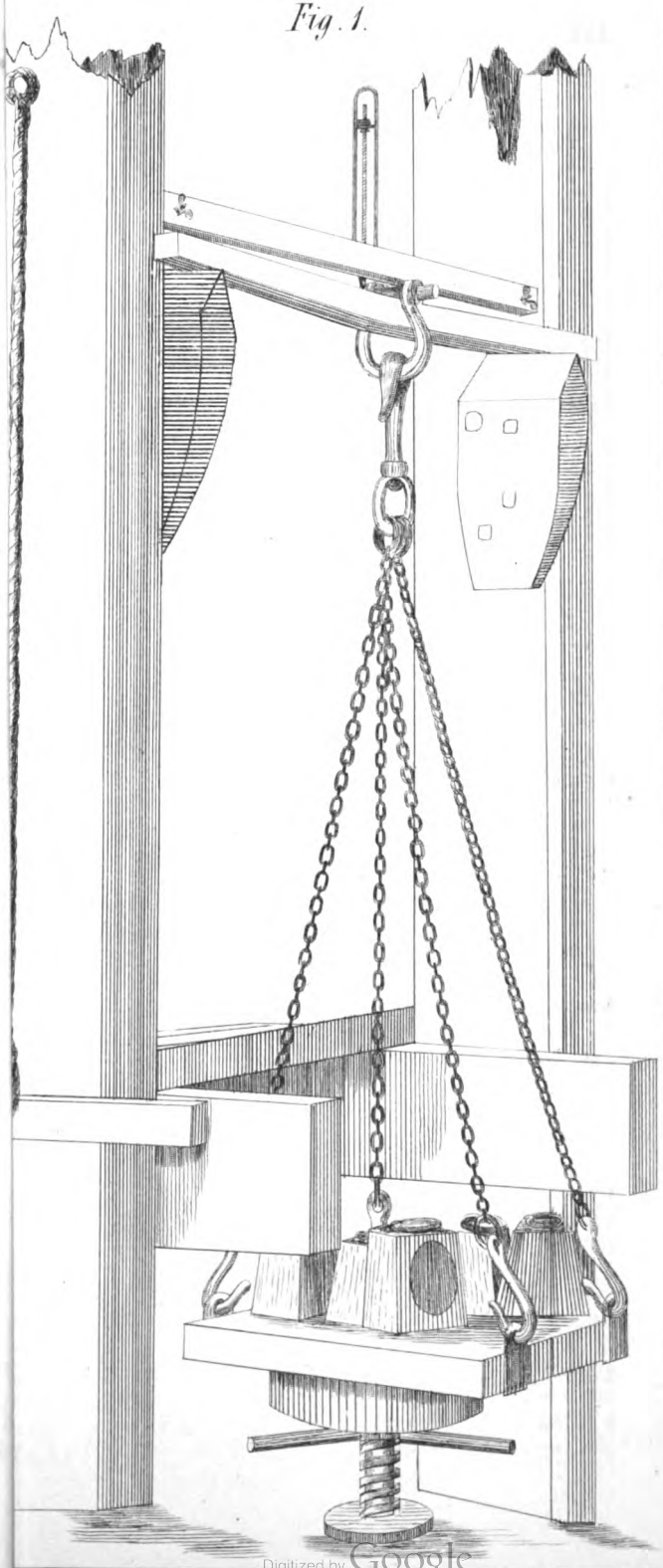

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TABLE VIII.

COMPARATIVE STRENGTH OF IRON CHAIN AND HEMPEN-ROPE, FROM EXPERIMENTS MADE IN H. M. DOCKYARD, WOOLWICH.

Length.	Weight.		Dimensions.		Proof weight.	Remarks.
	Chain.	Rope.	Chain diameter	Rope circumference.		
fathom.	lbs. oz.	lbs. oz.	inches	inches	tons	
1	160 0	... ...	1¼	...	31½	The chain is short linked. The links not to exceed 5 diameters of their iron, in length.
...	144 0	... ...	1⅛	...	27	
...	116 0	... ...	1⅛	...	22½	For ships' rigging, cranes, pumps, &c.
...	104 0	... ...	1⅛	...	18½	
...	84 0	23 2	1¼	10	15½	
...	63 0	19 15	1	9½	12	The rope used as follows.
...	56 0	17 14	⅞	9	10½	For breechings of guns.
...	48 0	13 5	⅞	7½ & 8	9½	
...	40 0	10 14	¾	7	7½	
...	36 0	9 6	¾	6½	6½	
...	29 0	7 15	⅝	6	5½	Slings for sling-carts, and wagons, triangle gyns, and slings for heavy guns.
...	26 0	6 10	⅝	5½	4½	
...	21 0	5 7	½	5	3½	For parbuckling and breechings of light guns.
...	17 0	4 6	½	4½	3	
...	13 0	3 7	½	4	2½	
...	10 0	2 10	⅜	3½	1½	Fall of triangle and Gibraltar gyns. Heavy drag and prolong ropes, traces and preventer rope.
...	8 0	1 15	½	3	1½	Luff tackles and light prolongs.
...	7 0	1 6	⅜	2½	½	Light drag ropes, erecting tackle for gyns, and grummets of large shot and shell boxes. Lashing ropes are 1½ and 1 inch.
...	6 0	1 0	¼	2	½	

List and Description of Old Guns and Mortars, English and Foreign, found in the Royal Military Repository at Woolwich, in the Royal Arsenal at Woolwich, and in the Tower of London. By Lieut. EDGAR, R.A., M.A.

[Read October 5, 1859].

[The guns are arranged, as far as possible, according to the nations to which they belong, and in chronological order.]

OF the *foreign* guns, some are extremely curious from their inscriptions; more especially those brought from Malta, pp. 177, 178, 179, 180, 184, the Florentine guns, pp. 191, 192, a Dutch gun, p. 170, No. 81; a French gun, p. 172, No. 95, some Portuguese guns, p. 175, and amongst the miscellaneous guns, p. 204.

Peculiarities in construction amongst the *foreign* guns may be seen, *e.g.* at p. 170, No. 81, *a Dutch revolving gun with seven bores;* at p. 172, No. 132, an Indian flat gun.

A French gun with three bores, at p. 172, No. 95; a wooden cannon used by the Canadian rebels, at p. 183, No. 762, an ancient brass breech-loader from Gambia, at p. 183, No. 980, a curious Indian brass mortar in the shape of a tiger, at p. 203, an Indian brass gun, with an iron cylinder in the bore, at p. 203.

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During the late disturbances in India, some wooden guns wrapped round with leather were taken from the mutineers. Probably there are still many curious old guns at Malta. The arsenal at Constantinople is known to contain many very ancient brass guns. There are also some old guns in the United Service Institution, Whitehall; some chambers, a few Dutch guns, and some gingalls from China, &c.

With regard to the English guns, it is generally understood that all the cannon used until Henry VIII. time, were of foreign manufacture. Two foreigners were then employed as gunfounders in England. They are mentioned by Stowe, 'In that year,' (1543), he says, 'the king employed two aliens as his gunfounders, one Peter Baude, a Frenchman born, a gunfounder or maker of great ordnance, and one other alien, called Peter Van Collen, both the king's feedmen. And after the king's return from Boulogne, the said Peter Baude by himself did also make certain ordnance of cast yron of diverse sorts and forms, as fawconets, falcons, minions, sakers, and other pieces.' Accordingly we find the name of this 'Peter Baude' on one of the guns in the Tower of London, at p. 193.

The next earliest recorded name is that of 'Franciscus Arcanus, an Italian,' A.D. 1529, p. 158, No. 1; then we have the names of 'John and Robert Owen,' A.D. 1538, p. 158, No. 4; and of 'Tomas Owen,' 1550, p. 159, No. 8.

These Owens' are also mentioned by Stowe, 'About the latter part of the reign of Henry VIII.', he writes, 'three brethren that were gunfounders, surnamed Owens, got ground there (in Houndsditch) to build upon, and to inclose for casting of brass ordnance. These occupied a good part of the street on the field side.'

We have also three other gunmakers mentioned, who lived before the 17th century, 'John and Tomas Mayo,' A.D. 1554, p. 159, No. 9; and 'Henri Pit,' A.D. 1590, p. 160, No. 10.

For peculiarities in the construction of the English guns, see pp. 156, 157, 158, 159, 168, 169, 190, 191, 192, 193, 195.

The most ancient gun probably is at p. 156, No. 106, a serpent gun of Henry VI. time 1422-1461. There are two iron peteraras, p. 157, No. 136, p. 192, and one brass, p. 192, assigned to the time of Edward IV. 1461-1483. There is a very curious old breech-loading gun, though now imperfect, at p. 168, No. 141; and a still more curious piece of ordnance with nine bores, 'for discharging nine shells at once,' see p. 195. There are also many old guns, without dates assigned to them.

For curious inscriptions on the *English* guns, see pp. 158, 159, 160, 163, 187, 189, 193, 194.

There are still probably many old guns about England, which will be required to complete the list. There is Queen Elizabeth's 'Pocket Pistol' at Dover; and the 'Mons Meg' at Edinburgh.

English Guns in the Royal Military Repository at Woolwich.

No. 106:[1]—

This gun and the following one are two of the serpent guns of the time of Henry VI. (1422-1461).

This one (106),[2] is broken into two pieces, about half-way between the trunnions and the breech. The cascable has apparently been broken off.

From the end of the gun where the cascable should be, as well as at the fracture, it appears that the gun is made of 7 bars of iron (composed of thin

[1] The numbers throughout are those of the old official catalogue.

[2] The date assigned to this gun in the old catalogue is A.D. 1422, the beginning of Henry VI. reign.

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layers of iron worked together) placed longitudinally, and bound together in a circle by iron hoops, which increase in thickness towards the breech.

The bore is very much eaten away with rust. The vent is large, about ⅜ in. in diameter, and much worn away. Length of the gun 7 feet 5½ in.; calibre 4·25 in.; weight of the gun 8 cwt.; length of trunnions 3½ in.; diameter 4 in.

No. 107 :[1]—

This gun also is one of the serpent guns of Henry VI. It is similar to the last in make. It has two rings fastened in loops, just above the trunnions, for the purpose of raising it. There is a small patch on the surface of the piece, about 32 in. from the base ring, and another on the muzzle mouldings to lay the gun by. The loops which bind the bars of iron of which the gun is made, are about 2 inches in width, and increase in thickness toward the breech. Length of the gun 8 ft. 6 in.; calibre 4.25 in.; weight 8 cwt. 2·14; diameter of trunnions 4 in.; length of trunnions 4 in.

No. 136 :[2]—

A 'peterara' of forged iron of the time of Edward IV. (1461-1483). This gun is made of longitudinal bars of iron, hooped together with iron rings. It has its chamber quite complete, with an iron ring to lift it by. The vent in the chamber is distinct. Length of the gun 3 ft.; calibre 2·5 in. (See Fig. 1.)

Nos. 103 and 104 :[3]—

Two iron guns of the pattern of the time of Henry VIII. (1509-1547), both brought from Ireland. Length of both 10 ft.; calibre of both 6 in.; weight of No. 103, 53 cwt. 0·14; weight of No. 104, 53 cwt. 0·6.

No. 108 :—

An iron gun of Henry VIII. time. 'This gun was raised out of the river Medway, near Chatham, and is believed to be amongst the first of the cast-iron guns towards the end of the reign of Henry VIII., about A.D. 1540' (*old catalogue*). The gun is very much eaten away with rust. There were originally fittings for a clasp to cover the vent, but they are now quite worn away. Similar covers are found on several of the guns of this period, and not on any other English guns. Length of the gun 8 ft. 9 in.; calibre about 3·75 in.

No. 112 :[4]—

An iron gun of Henry VIII. time. It has a hinged cover for the vent. Length of gun 6 ft. 4 in.; calibre 2.4 in.

No. 113 :[4]—

An iron gun of Henry VIII. time. The cascable is formed in the shape of a pineapple, and with a small bolt through it. Length of gun 3 ft. 4 in.; calibre 1·75 in.

No. 114 :[4]—

An iron gun of Henry VIII. time. It is quite plain, without date or

[1] The same date assigned as the last.

[2] The date assigned in the old catalogue is A.D. 1461, the beginning of Edward IV. reign.

[3] The old catalogue states these guns to be of the pattern of Henry VIII. reign, and assigns their date as 1509, the beginning of his reign.

[4] The date is taken from the old catalogue.

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device, but the pattern appears to be of this period. Length of gun 5 ft. 1 in.; calibre 3·25; weight 6 cwt. 1·12.

No. 1:—

A 'sakeret,' brass, of Henry VIII., date A.D. 1529. On the muzzle mouldings is the name of the maker,

'Franciscus Arcanus.'

On the 2nd reinforce, the inscription,

'Pour defendre.'[1] To defend.

On the 1st reinforce the words,

'Henricus VIII. Angliæ et Franciæ, Rex, fidei defensor, et dñs. Hiberniæ, A.D. MCCCCCXXIX.'

Henry VIII., King of England and France, Defender of the Faith,[2] and Lord of Ireland, A.D. 1529.

This inscription is underneath a crown and rose in relief. Length of the gun 6 ft. 11 in.; calibre 3·75 in.

No. 2:—

A 'saker,' brass, of Henry VIII., date A.D. 1535. On the chase is the name of the maker,

'Franciscus Arcanus, Italus.' Franciscus Arcanus, an Italian.

On the 1st reinforce, a crown and rose in relief, underneath them the letters,

'H. R. VIII. A.D. 1535.' King Henry VIII., A.D. 1535.

On the base ring, 'Sacro WIII.'

The external shape of the gun is duodecagonal, or twelve-sided. Length of the gun 7 ft. 11 in.; calibre 3·75 in.

No. 3:—

A 'culvering bastard' of Henry VIII., brass; recovered from the 'Mary Rose,' which was lost off Portsmouth in 1545. On the reinforce, a crown and rose in relief, with the motto, 'Honi soit qui mal y pense,' in a scroll round it. The letters 'H. R.' underneath, and then the inscription,

'This colveryn Bastard weys ZZQQ.'

The hinge fittings are still on the gun for the vent cover; the vent is large, being 1 inch in diameter at the orifice, but gradually growing smaller. This gun is also duodecagonal. Length of gun 8′ 6″; calibre 4·5″.

No. 4:—

A 'saker' of Henry VIII. A.D. 1538, brass. On the reinforce, a crown and rose with the motto, 'Honi soit, &c.' Underneath, the words

'Henricus Octavus.' Henry VIII.

Then a second inscription,

'John and Robert Owyn, bretheren, made this Socar, weying IZIZ Anno Dni. 1538.'

Length of gun 7′ 9″; calibre 3·75″.

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[1] The inscription 'Pour defendre,' seems to correspond to that on No. 16, 'In defence.'

[2] The title 'Defender of the Faith,' conferred on Henry VIII. A.D. 1521.

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No. 5 :—

A 'cannon royal,' of the time of Henry VIII. A.D. 1538, brass. It was recovered from the wreck of the 'Mary Rose,' lost off Portsmouth in 1545. On the chase are two roses in relief, hinge fittings for a clasp remaining on the vent field. The dolphins represent two lions' heads; the loop or handle is formed by their mouths being closed only at the front teeth. On the 1st reinforce the inscription,

'Henricus VIII. Anglie Francie et Hibernie rex, Fidei defensor invictissimus, *f.f.*[1] MDXXXVIII.'
'H. VIII.,

Henry VIII. king of England, France, and Ireland, the invincible defender of the Faith caused this to be made, 1538,

On the base ring,

'Arcanus de Arcanis Cesenen,[2] fecit.' Arcano dei Arcani of Cesena,[3] maker.

Length of the gun 8′ 6″; calibre, 8·5″.

No. 6 :—

A brass gun of Henry VIII. A.D. 1542. The dolphins represent two human figures with wings in the place of arms, and fishes' tails for legs. The figures have their backs hollowed from the gun so as to form a loop. On the 1st reinforce, a crown and rose in relief, underneath these the words,

'Henricus VIII. Anglie Francie et Hibernie rex, fidei defensor invictissimus, *f.f.*[1]
MDXXXII. H. VIII.

Henry VIII. king of England, France, and Ireland, the invincible defender of the faith, caused this to be made.

1542. Henry VIII.

On the base ring,

'Arcanus de Arcanis Cesenen, fecit.' Arcano dei Arcani of Cesena, maker.

This gun was also recovered from the 'Mary Rose.' Length of gun 10′ 11″; calibre 5′ 5″; weight 43 cwt. 0·25.

No. 7 :—

A brass gun of Henry VIII. A.D. 1542, with similar inscriptions to the last gun. It was recovered from the 'Mary Rose,' but is very much worn from the action of the water. The dolphins represent lions' heads. It is called in the old catalogue, a 'demi-cannon ordinary.' Length of gun 11′; calibre 6·25′.

No. 8 :—

A 'fawcon' (catalogue) of Edward VI., A.D. 1550, brass. On the gun is represented a shield with three lions passant on it; underneath is an inscription,

'Tomas Owen made this pese for the yel of Garnse, vhan Ser Peter Mevtas vas Governor and Captayn, Anno Dni. 1550.'

Length of gun 6′; calibre 3″; weight 6 cwt. 0·8.

No. 9 :—

A 'fawcon' of the time of Mary, A.D. 1554, brass. On the 1st reinforce, a rose, with the letters 'M. R.' (Maria Regina) underneath; then the words,

'John and Thomas Mayo, bretheren, made this pece, Anno Dni. 1554.'

Length of gun 7′ 6½″; calibre 2·875 in.

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[1] *f.f.* is a contraction for 'fieri fecit.' [2] 'Cesenen' is a contraction for 'Cesenensis.'
[3] Cesena is in the Pontifical States.

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No. 126:—

An iron gun of the reign of Queen Elizabeth (1558-1603). There is a crown and rose on the 2nd reinforce. Length of gun 9′ 6″; calibre 7″; weight 59 cwt. 0·11.[1]

No. 10:—

A 'culverin' (catalogue) of Elizabeth's reign, brass. On the 2nd reinforce, a crown and rose, with

'Elizabetha Regina.' (Queen Elizabeth).

On the 1st reinforce the inscription,

'Henri Pit made this pece, 1590, 18-pr.'

Length of gun 8′ 6″; calibre 5·75 in.

No. 11:—

A brass gun of the time of Charles I. On the chase, the representation of a crown, with an anchor and a rose underneath, and the words,

'Carolus Edgari sceptrum stabilivit aquarum.'[2]
Charles hath established Edgar's sceptre of the waters.

On the reinforce, the inscription,

'Mountjoye, Earle of Newport, Master-General of the Ordnance.'

and then,

'John Browne made this pece.'

Length of gun 9′; calibre 4·5 in; weight 20 cwt. 0·23.

No. 12:—

A brass gun of Charles I. On the reinforce, the rose and crown with the letters C. R. (Carolus Rex) underneath; then the same inscription as on the reinforce of the last gun; length of gun 3′ 8½″; calibre 3 in.; weight 2 cwt. 2·25.

No. 13:—

A brass gun, assigned 'from its appearance' in the old catalogue, to the time of the Commonwealth, A.D. 1650; it is without date, device, or inscription; length of gun 3′ 9″; calibre 2 in.

No. 14:—

A brass gun of Charles II., A.D. 1661. On the base ring is the inscription,

'Gerard Koster me fecit a°. 1661.'
Gerard Koster made me in the year 1661.

The dolphins have been broken off. The vent is in the centre of a small raised patch. Length of gun 3′ 3¼″; calibre 2·75 in.

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[1] The old catalogue assigns this gun to Elizabeth's reign.

[2] 'Carolus Edgari sceptrum stabilivit aquarum.' This device was adopted by Charles I. after the dispute with the Dutch about coast fisheries. Edgar was the first Saxon king who commanded a large fleet, and could keep his coasts clear of the Danes, hence, sometimes called, 'The Founder of the British Navy.'

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No. 15 :—

A brass gun of Charles II. A.D. 1669. On the 1st reinforce a rose and crown; then underneath,

'Carolus II.'
'1669.'

The vent is formed in the centre of a large hole ⊙ which extends but a short way into the metal. Length of gun 6′ 11″; calibre 2 in.

No. 109 :—

An iron gun of Charles II., A.D. 1673. On the 1st reinforce, the words

'9-pr.'

Then,

'Sir Thomas Chicheley Knight, Master-General of His Majesty's Ordnance.'
A. MDCLXXIII.

On the vent field, the letters 'F. B.' Length of gun 6′ 7½″; calibre 4·5 in.; weight 6 cwt. 1·0.

No. 121 :—

'A 32-pr. iron howitzer, of the time of Charles II.' (*old catalogue*). Length of gun 2′ 9″; calibre 6·25 in.; weight 6 cwt. 1·0.

No. 122 :—

The same as the last howitzer, No. 121, except that the weight is 6 cwt. 2·17.

No. 16 :—

A brass gun of the time of Charles II. A.D. 1676, richly ornamented. On the 1st reinforce, the words, 'In defence.'[1] Underneath them a crown with the royal arms, and supporters, and the motto, 'Honi soit, &c.' in a scroll round it. In a second scroll underneath, 'Dieu et mon droit.' Then the inscription,

'Carolus secundus, Dei gratia, magnæ Britanniæ Hiberniæ, et Galliæ, Rex, 1676.'
Charles the Second, by the grace of God, King of Great Britain, Ireland, and France, 1676.

On the base ring,

'Johannes Ouderogge me fecit Roterodami.' John Ouderogge made me at Rotterdam.

The dolphins representing two fish, are very handsome. Length of gun 6′ 6″; calibre 3·5 in.; weight 9 cwt. 1·16.

No. 17 :—

Corresponds to No. 16 in everything, except calibre 3·75 in.; weight 9 cwt. 1·10.

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[1] Analagous to the inscription 'Pour defendre' on No. 1 gun, p. 158.

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No. 18:—

A brass gun of the time of James II. A.D. 1685. On the 1st reinforce the inscription,

'Jacobus II., Mag. Brit. Fra. et Hib. rex, anno regni sui primo.'
'Dñs.[1] Georgius Legge, Baro de Dartmouth, rei tormentariæ bellicæ præfectus generalis.'
3-pr.
James II., King of Great Britain, France, and Ireland, in the first year of his reign.
Lord George Legge, Baron Dartmouth, Master General of the Ordnance.

Length of gun 6′; calibre 3 in.; weight 7 cwt. 3·23.

No. 19:—

Corresponds in all particulars, inscriptions, &c. to the last gun, except length of gun 4′ 6″; weight 6 cwt. 0·14; the calibre being the same, 3 in.

No. 20:—

A brass gun, supposed to be of the time of Charles II. (*old catalogue*). It has no date or inscription, but is supposed to have been cast about this period from its form and ornaments. It has the ordnance mark upon it. The dolphins have been broken off. Length 4′ 9″; calibre 3·25 in.

Nos. 21 and 22:—

Two brass guns of the time of William and Mary, A.D. 1695. On the 1st reinforce,

'Gulielmus et Maria, Mag. Brit. Franc. et Hib. rex et regina, anno regni sexto.'
'Henricus Dñs. vice-comes Sydney de Shepey, Baron de Milton, rei tormentariæ præfectus generalis. By Philip Wightman.'
William and Mary, King and Queen of Great Britain, France, and Ireland, in the sixth year of their reign.
Henry, Lord Viscount Sydney of Shepey, Baron Milton, Master-General of the Ordnance.

The vents of both are large, about half an inch at orifice. Length of guns 6′ 6″; calibres 3·375 in.

No. 46:—

Corresponds in date, inscription, and all particulars to the last two guns Nos. 21 and 22, except length of gun 9′; calibre 4 in.; weight 19 cwt. 0·21. The vent is large. The dolphins represent two porpoises.

No. 45:—

A brass gun of William III. time, A.D. 1696. On the 1st reinforce,

Gulielmus Tertius Mag. Brit. Fran. et Hib. rex, anno regni septimo.'
Henricus, comes de Romney, vice-comes Sydney de Shepey, Baro de Milton, rei tormentariæ præfectus generalis. By Philip Wightman.'
William the Third, King of Great Britain, France, and Ireland, in the seventh year of his reign.
Henry, Earl of Romney, Viscount Sydney of Shepey, Master General of the Ordnance.

The vent is enlarged. Dolphins representing two porpoises. Length of gun 9′; calibre 4 in.; weight 19 cwt. 2·26.

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[1] 'Dñs.' is a contraction for Dominus. 'Res tomentaria bellica,' means ordnance, artillery.

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No. 23 :—

An 8-inch brass howitzer of William and Mary's reign, A.D. 1695. The inscriptions on the reinforce are just the same as on Nos. 21 and 22, p. 162. Length of howitzer 3′ 7½; calibre 8 in.; weight 15 cwt. 2·22.

No. 24 :—

A brass gun of Queen Ann's reign, 1706. On the 1st reinforce, the inscription,

'Anna, Magnæ Britanniæ, Franciæ, et Hiberniæ regina, anno regni quarto.'

'Johannes, Baro Churchill, dux et comes de Marlborough, Mag. Brit. reginæ, a consiliis secretioribus, præclari ordinis periscelidis eques, rei tormentariæ et copiarum Britannicarum præfectus generalis, sacri Romani imperii princeps. Bagley, fecit 1706.'

Anne, Queen of Great Britain, France, and Ireland, in the fourth year of her reign.

John, Baron Churchill, Duke and Earl of Marlborough, Member of the Queen of Great Britain's Privy Council, Knight of the Noble Order of the Garter, Master General of Ordnance, and Commander-in-Chief of the British forces, a Prince of the holy Roman Empire. Bagley, maker, 1706.

There are dolphins on the gun. Length of gun 7′; calibre 3 in.; weight 10 cwt. 1·17.

No. 25 :—

A brass gun burst at the chase, during a cast at the Royal Foundry, Moorfields, in 1716, in consequence of allowing the metal to run into a damp mould. Length about 11 ft.

No. 47 :—

A 13-inch brass mortar, with the date 1726. On the chase a coat of arms, with the motto, "Honi soit" in scroll round it. In another underneath the motto of the family of the Duke of Argyle[1] (to whom the arms belong),

'Vix ea nostra voco.' I scarce call these things our own;

alluding to the honors of ancestry. On the reinforce, the royal arms and mottoes. Then 'Schalch, fecit, 1726,' Schalch, maker, 1726, on the breech. The vent pan represents the head of a demon; the dolphins two porpoises. Weight 81 cwt. 2·24.

Nos. 26 and 27 :—

Two brass guns, with date 1732. On 1st reinforce, royal arms and mottoes. On base ring, 'A Schalch fecit, 1732.' Length of gun 3′ 6″; calibre 2·25 in.; weight 2 cwt. 3·16 of No. 26, and 2 cwt. 3·14 of No. 27.

No. 28 :—

A brass gun, with date 1742. In relief on the chase the arms of the family of Shannon, with the motto in a scroll underneath,

'Spectemur agendo.' Let us be tried by our actions.

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[1] The Duke of Argyll was M.G. in 1726.

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A scroll surrounding the arms with the motto, 'Honi soit, &c.' On the 1st reinforce are the royal arms and mottoes. On the base ring,

'Bowen, fecit, 1742.' Bowen, maker, 1742.

'This gun is said to have been made for experiments in quick firing; the cascable being bored through to admit a hot iron to fire the charge,' (*old catalogue*). Length of gun 6′ 11″; calibre 3 in.; weight 11 cwt. 3·19.

No. 29:—

'One of the light 12-pr. guns, brass, that were made in a particular manner with different sorts of metal, under the direction of the Saxon Colonel Ludvig Widenman, at Chelsea, in the year 1747, by order of H. R. Highness William Duke of Cumberland, by way of experiment, but which guns upon trial were found not to be equal in goodness to light guns, cast all of good gun metal in the English manner.'

This is inscribed on the 1st reinforce. The vent is in rear of the base ring. There are four holes in the metal between the trunnions, probably to fasten dolphins in. Length of gun 6′ 8″; calibre 4·75 in.

No. 30:—

A brass gun, similar to the last, No. 29, except that it is a 6-pr. instead of a 12-pr., and in length is 5′ 1″; in calibre 3·625 inches.

No. 31:—

Is similar to the last, No. 30, in everything except that it has no cascable, the breech being quite flat.

No. 89:—

A brass gun with date 1748. It is exactly similar to No. 28 (p. 163), in arms, ornaments, and inscriptions on chase and 1st reinforce. On the base ring,

'A. Schalch, fecit, 1748.'

No. 32:—

A brass gun, with date 1748. On the chase, a coronet with the letter 'M.'[1] On the reinforce, 'G. R.' under a crown. On the base ring,

'A Schalch, fecit, 1748.'

Length of gun 5′; calibre 4·75 in.; weight 9 cwt. 0·3.

No. 33:—

A brass gun with date 1756. On the 1st reinforce, the letters 'G. R.' under a crown. On the base ring,

'R. Gilpin, fecit, 1748.'

The vent half-an-inch in diameter at the orifice. 'This gun was burst at St Lucie in 1783, in consequence of the gunner using a piece of turf as a

[1] 'M' would be the initial letter of the name of then Master-General.

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wad, when firing the evening gun, (*old catalogue*). Length of gun 4′ 6″ calibre 4 in.; weight 4 cwt. 2·22.

No. 34:—

'A brass gun with date 1756. On the chase, a coronet and letter 'M.' On reinforce, crown and letters 'G. R.' On the base ring, 'A. Schalch, fecit, 1756.' There is a curious grapple in the muzzle of this gun, 'invented by Serjeant Bell, R.A., and intended to be fired from a light 6-pr. up a precipice, having a rope ladder attached by which a man can ascend,' (*old catalogue*). Length of gun, 4′ 6″; calibre 4 in.; weight 5 cwt. 0·9.

No. 90:—

A 10-inch brass mortar, with date 1760. On the muzzle, the royal arms and mottoes. On the reinforce, a coat of arms with the motto,

'Tria juncta in uno.'[1] Three united in one.

In a scroll underneath the arms, another motto,

'A rege et victoriâ.' From the king and victory,

Under the vent the name of the maker, 'W. Bowen, fecit, 1760.' 'This mortar and the following one (No. 91), were rendered unserviceable by experiments with detonating powder, by the late Lieut.-General Sir W. Congreve,' (*old catalogue*). Weight 31 cwt. 1·24.

No. 91:—

Corresponds to the preceding mortar (No. 90) in every particular, except that weight is 32 cwt. 0·24.

No. 125:—

An iron gun of the reign of George III. 'with wrought-iron breeching loop, as originally used by the navy, (*old catalogue*). The gun shews great thickness of metal at the muzzle. The letters 'G. R.' under a crown on the 2nd reinforce. Length of gun 5′ 6″; calibre 3·25 in.; weight 11 cwt. 1·26.

Nos. 127—130:

Are four iron guns cast on cores, their breeches being cut off to show the inaccuracy of that system of casting guns.

127. Length of gun 7′ 10″; calibre 5·5 in.

128. Length of gun 7′ 1″; calibre 5·5 in. Weight 22 cwt. 1·9. There is a ball remaining in the bore.

129. Length of gun and calibre cannot be ascertained, the gun being broken into three pieces. Weight 49 cwt. 1·8. The trunnions have been knocked off. The letters 'G. R.' under a crown on 2nd reinforce.

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[1] The motto 'Tria juncta in uno,' is that of the Order of the Bath. The badge of the Order was three Imperial crowns typifying those of England, Ireland, and Scotland, and hence the motto surrounding it.

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130. Weight 49 cwt. 1·25. Length and calibre cannot well be ascertained. The letters 'G. R.' on 2nd reinforce.

No. 36 :—

A brass gun of the date 1776. On the base ring,

'J. et P. Verbruggen, fecerunt, A°. 1776.'

J. and P. Verbruggen, makers, in the year 1776.

Length of gun 3′; calibre 3 in.; weight 1 cwt. 3·10.

No. 37 :—

A brass gun with the date 1776. On 1st reinforce under a crown,

'G. R. 1776,'

on base ring,

'J. et P. Verbruggen, fecerunt.'

Length 6′ 11″; calibre 2 in.; weight 3 cwt. 1·12.

No. 38 :—

A brass gun, with date 1777. On base ring,

'J. et P. Verbruggen, fecerunt, A°. 1777.'

On 1st reinforce under a crown,

'G. R.'

Length 7′; calibre 2 in.; weight 6 cwt. 3·3.

No. 39 :—

A brass gun with date 1778. On the chase the 'T' (the initial of the name of the Marquis Townshend, who was then M. G.) under a coronet.

On 1st reinforce under a crown,

'G. R.'

On base ring,

'J. et P. Verbruggen, fecerunt, 1778.'

Length of gun 5′; calibre 2 in.; weight 2 cwt. 2·12.

No. 40 :—

A brass gun with date 1788. On the chase the arms of the Townshend family, with the motto

'Hæc generi incrementa fides,'

Fidelity hath won these honors for our race;[1]

on the 1st reinforce, the royal arms and mottoes.

On base ring,

'J. et P. Verbruggen, fecerunt, A°. 1778;'

the dolphins are handsome, the vent is just above the neck of the cascable in the breech. Length 5′; calibre 3·75 in.; weight 10 cwt. 1·26.

No. 97 :—

A brass gun with date 1782. On base ring,

'J. et P. Verbruggen, fecerunt, A°. 1782;'

on the reinforce,

G. R.

[1] The motto and arms being to the family of Townshend. The Marquis Townshend was M. G. from 1772 to 1782, and again in 1783.

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This gun is mounted on a curious carriage intended to fire over a parapet; 'invented by Mr J. Cheetham, and deposited 12 Feb. 1840,' (*old catalogue*). Length of gun 3′ 6″; calibre 3 in.; weight 2 cwt. 3·4.

No. 145:—

An iron gun about 1782. On the reinforce,

'G. R.'

It was one of the guns recovered from the wreck of the 'Royal George,' in 1840, which was sunk at Spithead in 1782. The gun is very much corroded from the action of the water. Length 9′ 7″; calibre 7 in.; weight 56 cwt. 3·13.

No. 41:—

A brass gun with date 1794. On the chase a coronet and garter with letter 'R.' On the 1st reinforce underneath a crown,

'G. R.'

On the 1st reinforce ring,

'Francis Kirnman, 1794.'

Length of gun 5′; calibre 3·75.

No. 42:—

A brass gun with date 1814. On chase, a coronet and garter and the letter 'M.'

On 1st reinforce ring,

'H. & C. King, 1814.'

On 1st reinforce, a crown and the motto,

'Honi soit &c.'

Length 4′; calibre 3 in.

No. 43 and 44:—

Two brass howitzers with date 1814.

43 is a 10-in. and in length = 4′ 2″
44 „ 8-in. „ 3′ 4.″

On the chase, a crown with garter surrounding the letters 'G. R.' On the reinforce, a wreath with 'M' in it. On base ring,

'H. & C. King 1814.'

No. 110:[1]—

An iron gun without date. There is a plain shield on the 2nd reinforce, but no device or date. It is marked 'D,' i.e. faulty in dimensions. From its general appearance it might be a gun of the time of Henry VIII. Length 9′ 6″; calibre 4·28 in.

No. 111:—

An iron gun without date. From its appearance it might be a gun of Henry VIII. time. There is a plain shield on the 2nd reinforce, but no

[1] The 'lesser demy culverin' of date between 1628 and 1643, corresponds in its measurements to this gun. Length 9½ feet, calibre 4½.

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date or device. 'There is a circle of dentiles round the cascable and muzzle,' (*old catalogue*). Length 6′ 2″; calibre 3 in.

No. 115:—

An iron gun without date. It is curious from having the vent in a patch on the neck of the cascable, leading straight into the bore. It seems originally to have had some sort of lock over the vent. Length 5′ 1½″; calibre 3·5 in.

No. 116:—

An iron piece of ordnance called 'the twins,' and consisting of two barrels joined together. There is only one vent between the two breeches. 'This gun was proposed for firing chain shot from the tops of ships of war, and carries a 11 lb. shot,' (*old catalogue*). Length 2′ 6″; calibre of both bores 2 in.

No. 117:—

An old iron 4-pr. gun without date or device. Length 3′ 2″; calibre 3 in.

No. 118:—

An iron gun proposed 'for the naval service by General Bentham,' (*old catalogue*). Length 4′ 10″; calibre 6·25 in.

No. 119:—

An iron carronade with trunnions, 'General Bentham's pattern for naval service,' (*old catalogue*). Length 4′; calibre 4·5 in.

No. 120:—

An iron 8-in. mortar, said to be 'of the oldest date,' (*old catalogue*). Length 2′.

Nos. 121 and 124:—

Two 24-pr. iron howitzers, 'originally intended for Martello towers,' (*old catalogue*). Length 2′ 9″; calibre 5·5 in. No. 123, weight 11 cwt. 3·4. No. 124, weight 11 cwt. 2·25.

No. 100:—

A sort of mortar (brass) 'for discharging fireballs and similar fireworks,' (*old catalogue*). Length 1′ 8½″; calibre 3 in. (See Fig. 2).

No. 141:—

An iron breech-loading gun. This is a short gun, in length 2′ 2″, and in calibre 2 in. It is intended to be loaded at the breech, and is mounted on a curious kind of carriage. The bore is open at the breech, that is, extends through the metal at the breech. The hole *aa*, also extends through the metal both above and below the bore, and is evidently intended for a block of metal to be inserted after the charge has been put in. (See Fig. 3).

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No. 146 :—

An iron gun, without date. It was recovered from the wreck of the 'Edgar,' (*old catalogue*). On the 2nd reinforce there is a crown and rose. The gun is very much corroded. Length 10′; calibre 6 in.

No. 135 :—

An iron gun and carriage, raised in 1836 from the wreck of the 'Mary Rose,' sunk off Spithead in 1545. There are also two other pieces of guns, and two chambers. One of the guns has a stone shot in the bore. It is impossible to calculate their lengths or calibres from the crumbling state they are now in.

Nos. 137—139 :

Three ancient pieces of chambers, iron, very old and worn away.

No. 766 :—

An ancient forged iron gun, ornamented with silver, without a date, (*old catalogue*). Weight about 2½ cwt.; length 5′ 3″; calibre 3·25 in.

No. 389 :—

'A short gun or falconet in a perfect state, hooped with two rings made of bars of iron,' (*old catalogue*). Length 1′ 11″; calibre 1·6 in.

No. 362 :—

Two iron chambers, 'supposed for fireships,' (*old catalogue*). Length 10½ in.; calibre 3·75 in. The two vents are at the sides of the two pieces, contiguous to each other. (See Fig. 4).

No. 363 :—

A small double iron howitzer, somewhat similar in form to the preceding piece. It has only one vent; the trunnions are broken off, and a piece out of the side. Total length 11 in.; calibre 3 in.

No. 364 :—

A small iron mortar. Total length 10 in.; calibre 3·5 in. (See Fig 5).

No. 388 :—

A fragment of an ancient iron gun, formed of three iron plates made into the form of a hollow cylinder, strongly hooped together with hammered iron. 3′ 6″ in length; when first discovered, 10′ long, (*old catalogue*).

24-pr. without a number :—

A 24-pr. gun, iron, with date 1803. This gun is curious from having been used at the siege of St Sebastian. There is a large dent on the chase, where it was struck by a cannon ball, which passed in and killed the gunner laying the gun. The vent is greatly enlarged from continued firing. Length 9′; calibre 6 in.

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No. 761 :—

A gun formed of a cylinder of copper, round which a number of folds of leather are rolled, (*old catalogue*). Length 6′ 5″; calibre 2 in.; weight about 1 cwt. 7 lbs.

No. 755 :—

A brass gun with date 1535. On the base ring the words,

'Maistre Denis.'

On the muzzle mouldings,

'1535.'

It is a most curious and richly ornamented piece; the whole surface of the gun is covered with leaves, &c.; on the 1st reinforce near the base ring, are engraved the representations of the heads of men and women. The dolphins represent winged dragons; the cascable the head, shoulders, and bust of a woman. Length 7′ 3½″; calibre 1·75 in.

Dutch Guns in the Royal Military Repository.

No. 81 :—

A curiously constructed brass Dutch gun of 7 bores. It is apparently made to revolve in a kind of socket on its centre. Two arms extend from this socket to the breech, as if to be fastened to something (probably the carriage) and thus to clamp the gun. The dolphins and trunnions are on the socket. There are seven vents, quite distinct, and there was originally a cover to each of them.

On the muzzle mouldings is the inscription in English letters,

'Got allain die ehre in allen dingenn.'
To God alone the honor in all things.

On the chase, there are 4 shields round the gun, each with the inscription,

'Gotes hilf und unverdrossen,
'Hat mich Hans Reysinger gegossen;
'Mann nent mich ein buntzen in der not,
'Wirt einer aus mir troffen, her ihm Got.'

God's aid and the indefatigable Hans Reysinger have cast me. Men call me a defence in need. Should any one be struck by me, God help him.

On the reinforce,

'Wight' (weight) 8.3·0.

Length 3′ 9½″; calibre of all bores 1·75 in.

No. 763 in the Rotunda :—

An ancient brass piece much ornamented, with date 1570. 'On the 1st reinforce are the arms of the Empire of Germany,' underneath 'anno 1570,' (*old catalogue*). The trunnions and dolphins much ornamented. Length 5′ 7″; calibre 1·5 in.; weight about 2 cwt.

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No. 35:—

A brass gun with date 1769. On the 1st reinforce a coronet, with '1769' underneath it. On the base ring the inscription,

'In bburg ggossen.'
For the city of Gossen.

Length 3′ 5″; calibre 2 in.

No. 76:—

A brass Dutch gun, with date 1780. On the 1st reinforce a coat of arms, a lion rampant, in his right paw a sword, in his left seven arrows bound together, representing the United provinces, with the motto surrounding it,

'Concordia res parvæ crescunt.'[1]
By concord small things grow great.

On the base ring,

'Joh. Maritz, fec. Hag. A. 1780.'
John Maritz, maker, at the Hague in the year 1780.

The vent is in the centre of a small pan. Length 4′ 5″; calibre 3 in.

Indian Guns in the Royal Military Repository.

No. 49:—

A brass gun brought from Scinde. It is richly ornamented. There is a curious representation of the head of an animal on the muzzle. On the chase are two blank scrolls. The dolphins represent fish. Length 4′ 8″; calibre 3·5 in.

No. 50:—

A brass gun from Affghanistan, richly ornamented. On the chase an inscription in Indian characters. There are six rings in plain dolphins on the piece; four in front of the trunnions on the chase, two in rear. There is no cascable, for the gun is cut off quite straight at the base ring. The vent is a little on the right side of the gun, instead of being in the centre of the upper surface. Length 9′ 4″; calibre 3·75 in.

Nos. 93, 94:—

'Two highly ornamented brass guns (3-prs.) taken at Seringapatam, May 6, 1799,' (*old catalogue*). The muzzle, cascable, and trunnions, represent the heads of tigers. There is an inscription on the guns in Indian characters. 'Both guns were sent to the Royal Military Repository by order of His Majesty George IV., December, 1830,' (*old catalogue*). Length of guns 7′ 9″; calibre 2·75 in.

No. 142:—

'An iron swivel wall piece, mounted on a tripod, taken at Seringapatam, 1799,' (*old catalogue*).

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[1] The motto 'Concordia res parvæ crescunt' belongs to the old Republic of Holland, or the seven united provinces, typified by the seven arrows. The inscription on the base ring is a contraction for Johannis Maritz, fecit, Hagæ, anno 1780.

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Nos. 132, 133 :—

'Two Indian guns, iron, "from Kutch," sent by Lord Keane in 1839,' (*old catalogue*). (See Fig. 6).

The bore is divided into three compartments by two divisions of iron. No. 132 is the same in shape as No. 133, except that it is smaller. Total length 2′ 8″; length of bore 1′ 3½; width of bore 2·75 in. (See fig. 6).

No. 102 :—

A 27-in. brass mortar, brought from Madras. It was originally found concealed under ground in the Fort of Kurnaul, amongst many other brass pieces of ordnance. Kurnaul was the capital of a small independent district, after it had been added to the Madras territory. Most of these guns (there are others at the Tower, London) are of somewhat modern construction, and were intended, it was said, for the equipment of a powerful insurrectionary force, for the purpose of driving the British out of India,' (*old catalogue*). This mortar is very old; the date of the discovery of the guns was about 1838. It has small trunnions, weighs about 8¾ tons, and its extreme length is 7 ft.

French Guns in the Royal Military Repository.

No. 131 :—

'A French forged field gun of the 17th century,' (*old catalogue*). Length 8′ 11″; calibre 1·75 in.

No. 134 :—

'A French forged iron field gun (swivel) of the 17th century,' *old catalogue*). Length 6′ 2½″; calibre 1·25 in.

No. 95 :—

This gun, and the following (No. 96), are triple-bores, brass. They were taken from the French at the battle of Malplaquet, September 11, 1709. They are both highly ornamented. There are three vents, one for each bore.

On the chase are the three following inscriptions in separate scrolls:—

'Les parques.' The fates.
'Ultima ratio regum.'[1] The final argument of kings.
'Louis Auguste duc du Maine.'

On the first reinforce the inscription,

'Pluribus nec impar.'[1] Not an unequal match for numbers.

On the base ring,

'Direxit D. de S. Hilaire exercituu regis castroruo marescal art. legatu-general.'

Ordered by D. de St Hilaire, quarter-master-general of the king's army, deputy-general (or perhaps lieut.-general) of artillery.

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[1] 'Ultima ratio regum.'
'Pluribus nec impar.'

These mottoes were adopted by Louis XIV., probably about 1687, when he had almost all Europe against him. They were continued by his successors.

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On the breech,

'Figar Augustin,'

and underneath,

'Berenger de Falize, fecit Duaci, 1704.' Berenger de Falize, maker, Douay, 1704,

and then,

'H. F. T. M. invenit.'

This gun has no cascable. The left dolphin is broken off. The breech much ornamented. Length 3′ 11″; calibre 3·5 in.

No. 96 :—

A brass gun with triple bore, similar to the preceding (No. 95.) The ornaments and inscriptions also are the same, except there is on the chase,

'Le trimegiste,' instead of 'Les parques,'

and on the base ring,

'Berenger de Falize, fecit, Duaci, 1706.'

Length 4′ 3″; calibre 3·5 in.

No 67 :—

A French brass gun with date 1716. On the chase its name,

'La Frivole.' The Frivolous.

Then the representation of two field guns on carriage. On the 1st reinforce a coat of arms, though much obliterated. On the base ring,

'Berenger de Falize, fecit, Duaci, 1716.'

Length 6′ 11″; calibre 3·75 in.

No 71 :

A French brass gun with date 1743. On the base ring,

'Fait à Paris, 1743.' Made at Paris, 1743.

On the 1st reinforce a coat of arms surmounted by a crown, and supported by two Indian chiefs armed with bows and arrows. The coat of arms contains in the upper part fleurs-de-lis; in the lower the figure of a man reclining on the ground, supporting in his hand a crucible of fire. The vent is at one end of a narrow pan, which extends about 6 in. down the reinforce. Length 4′ 11″; calibre 2·75 in.

No. 86 :—

A French brass gun with date 1745. On the chase, in three separate scrolls,

'L'espion.' The spy.
'Ultima ratio regum.'[1] The final argument of kings.
'Louis Charles de Bourbon, comte d'Eu, duc d'Aumale.'

Then the representation of a shield, with fleurs-de-lis in it, surmounted by a crown, and supported by two field guns and carriages. On the 1st reinforce in a scroll,

'Pluribus nec impar.' Not an unequal match for numbers.

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[1] See note on opposite page.

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Then a coat of arms surmounted and supported as on the chase, all in relief. Underneath,

'Strasbourg, MDCCXLV.'

On the base ring the inscription,

'Fondu par Jean Maritz, commissaire des fontes de l'art^{rie}. de France.'
Cast by Jean Maritz, Superintendent of the foundries of the Artillery of France.

The dolphins are large; the vent is at one extremity of a narrow pan, which extends down the reinforce. Length 10′ 7″; calibre 6 in.

No 75 :—

A French brass gun, with date 1769. On the chase the name of the gun,

'Tarquin.'

On the 1st reinforce a crown. On the base ring,

'A Strasbourg le 28 Juin 1769, par J. B^{te}. Dartein, commis^{re} des fontes de l'art^{rie}.'
Made at Strasbourg 28th June, 1769, by J. B^{te}. Dartein, Superintendent of the foundries of the artillery.

Length 10′ 7½″; calibre 6·25 in.

No. 78 :—

A French republican gun. On chase the letters A. N. Then in a scroll,

'Liberté, egalité.'

On the breech,

'Perier freres, Paris.' The brothers Perier of Paris.

Length 6′ 1″; calibre 4·25 in.

No 92 :—

French brass 10-in. mortar, sea service, cast complete with its bed. There is a coat of arms on the muzzle; on the chase some fleurs-de-lis. It has one dolphin. The vent pan represents a man's face.

No. 99 :—

A French brass gun, 3-pr. The catalogue states it to be 'a 3-pr., mounted on its carriage with limber, taken in Egypt in 1801, by the 54th Regiment, and deposited in R. M. Repository in 1842.' On the reinforce,

'Marabo,'
'West Norfolk,'
'54 Regt.,'
'Egypt, 1801.'

Length 3′; calibre 3·15 in.

No. 143 :—

A French sea service 13-in. iron mortar, cast complete with its bed. There is a dolphin at right on the muzzle broken off. The mortar is chambered.

No. 144 :—

A French 10-in. iron mortar, sea service, cast complete with its bed. It is chambered as in Fig. 7.

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No. 765 in the Rotunda :—

'Carnot's 3½-in. French mortar, described in his treatise "*De la Defence de Places fortes.*" Weight 34½ lbs.' (*old catalogue*). It has a long wooden trail 3′ 9″, with flint hammer, and pan on the right side of the mortar; a groove leads from this pan to the vent, which is thus in the side of the mortar, on the level of its bed.

No. 98 :—

'A French brass gun, taken at Waterloo,' (*catalogue*). On the chase,

'Voltaire.'

On the reinforce the date,

'L'an 3^{e} de la republ^{que} Francaise.' The third year of the French republic.

On the base ring,

'A Dousi Bouquero 29 Brumaire.'

The tangent scale is broken off. There are plain dolphins. Length 6′ 11″; calibre 4·875 in.; weight 17 cwt. 1·9.

Guns brought from China, now in the Royal Military Repository.

No. 48 :—

A brass gun from China. On the reinforce the representation of an animal like a dog with a serpent in its mouth. Length 4′ 7″; calibre 4·5 in.

No. 55 :—

A *Portuguese* brass gun, *brought from China*, with date 1627. On the reinforce are the royal arms of Portugal, below which a cross, with the words,

'Da cidade de nome de deos da China.' From the city of the name of the gods of China.[1]

Then in a tablet underneath,

'Manoel tavares bo.'
'Carro afes, A. 1627.'

The dolphins represent fish; the button, the head of some animal somewhat like a shark. 'This gun was taken in and brought from China, by Lt.-Col. Knowles, R.A.' (*old catalogue*). Length 11′ 3″; calibre 10·5 in.

NOTE.—There is a similar gun in the Tower Collection.

Spanish Guns.

No. 56 :—

A Spanish brass gun with date 1662. It is richly ornamented about the rings; the dolphins represent porpoises. The vent is in a small raised

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[1] 'The city of the gods,' Macao.

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patch. The cascable resembles a pineapple. On the 1st reinforce are seven coats of arms; and underneath,

'Temporibus dominorum Garlefi Langebeck,'
'Et Johannis a Spreckelsen.'
In the time of the Lords Garlef Langebeck, and John of Sprekelsen.

On the base ring,

'Herman Benningk me fecit anno 1662.' Herman Benningk made me in the year 1662.

Length 6′ 3″; calibre 4·75 in.; weight 16 cwt. 1·21.

No. 68 :—

A Spanish brass piece with date 1718, much ornamented. On the chase are two scrolls with,

'Justicia.'
'Vibrat[1] fulmina regis.'
Justice wields the thunderbolts of the king.

On the 1st reinforce,

'Phil. V. Hisp. rex.' Philip V. king of Spain.

On base ring,

'Petrus Rebot, fecit, 1718.'

Length 7′ 5″; calibre 3·5 in.

No. 82 :—

A Spanish 5¾-in. brass mortar. On the chase the arms of Spain. One dolphin representing a fish. On the reinforce the mortar is chambered. Length 1′ 6″.

Polish Gun.

No. 66 :—

A 'Polish' brass gun, (*old catalogue*).

Bavarian Gun.

No. 754 :—

'An ancient Bavarian brass gun,' (*old catalogue*), with date 1566. Ornamented on the 1st reinforce 'with the arms of a Duke of Bavaria,' (*old catalogue*). Over the arms are the following letters and figures,

'15 A. H. I. B. 66.'

On the chase the letter 'A.'

On muzzle mouldings,

'Leonhart peringeri opus.'

The trunnions, dolphins, and whole gun, are very much ornamented. Length 3′ 11″; calibre 1·25 in.; weight 126 lbs.

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[1] It is doubtful whether it is not 'violat.'

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Guns of the Knights of St John (or of Malta).

No. 51:—

A brass gun brought from Malta, with date 1551. On the reinforce, a shield with three fleurs-de-lis, surmounted by a crown. Underneath, the letters 'H. H.' in a scroll, and on each side of them a crescent. The exterior surface of the gun is octagonal. On the base ring the date '1551.' Length 9′ 1″; calibre 3 in.

No. 52:—

A brass gun from Malta. On the 1st reinforce there are three curious figures, half-human, with horns, in relief. On the 2nd reinforce, a figure in strong relief resembling a representation of the Virgin and Child. The bore is somewhat torn; there is an iron ball resting in it. Length 6′ 7″; calibre 2·5 in.

No. 53:—

A brass gun from Malta, with date 1571. On the chase are the Venetian arms; a figure in relief resembling a winged lion with an open book in its paws, i. e. the lion of St Mark. Underneath, the letter or symbol 'X.' Then 'C. D. X.' underneath. On the reinforce, the letters 'A. G,' with a coat of arms between them. Underneath this, 'P. S. A.' Then 'M.D.LXXI.' 'S. A.' Length 9′ 11″; calibre 3 in.

No. 54:—

A brass gun from Malta, with date 1600. On the chase the name of the gun,

'Der Helffant.' The Elephant;

and the figure of an elephant in relief underneath. Then the following elegiacs:—

'Cattorum[1] princeps peragrans Ludovicus amæna
Galliæ et Hispani regna opulenta soli,
Venerat in Meliten pelago; susceptus honore
Magno, permagnis obrutus ac meritis,
Per mare, Siciliâ visâ, Italiæque per arva
In patriam ut rediit, salvus et incolumis,
Molem hanc belligeram, Melitensi equitum ordini ut esset
Grati animi signum, firmæ et amicitiæ,
Giesside de castro[2] donatam misit—Acerbe
Sentiat hanc hostis, fac, pie Christe, tuus.'
'Actum anno Christi MDCXIX.'

Louis, prince of Hesse, after traversing the pleasant realms of France, and fertile kingdoms of Spain, came by sea to Malta. Having been received with great honor, and loaded with numerous presents, as he returned safe and uninjured to his own country over the sea, after visiting Sicily, through the fields of Italy, he sent this engine of war as a present from the castle of Giessen, to the Order of Knights of Malta, that it might be a mark of his gratitude and constant friendship. Grant, merciful Christ, that thy enemy may feel it bitterly.

Done in the year of Christ 1619.

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[1] 'Cattorum,' &c. The Catti were the people of Hesse.

[2] 'Giesside de castro.' Giessen is in Hesse, on the river Lahn.

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On the reinforce, a coat of arms, with the date '1600' under it, and above it the letters,

I. G. G. I. A. N.

On the base ring,

'Gosmich Jacob Retenberger.'

The dolphins represent lions; there are the faces of cherubim round the reinforce, at the vent. There is a loop in place of the cascable, and on it the face of a lion. Length 11′ 1″; calibre 7·25 in.

No. 57 :—

A brass gun from Malta. The catalogue gives the date 1680. On the chase, an anchor with a crescent over the fluke. On the 1st reinforce, two coats of arms, surmounted with crowns. On the 2nd reinforce, the bust of a man enclosed in a semi-wreath. On the base ring,

'Com^{re} de Lom. d. Castellet.'

The button represents the head of a demon. Length 8′ 1″; calibre 3·5 in.; weight 14 cwt. 1·7.

No. 58 :—

A brass Malta gun, with date 1680. On the 1st reinforce, two coats of arms surmounted with crowns. Underneath them, a flower surmounted with a coronet; then '1680.' On the base ring,

'Com$^{re.}$ dell arteglieria fra. Gasp^{ro} de Tresemanes Chastueil Brunot."[1]
Brother Gaspar de Tresemanes Chastueil Brunot, Superintendent of the artillery.

Length 8′ 2″; calibre 3·5 in.; weight 16 cwt. 2·0.

No. 59 :—

A brass gun from Malta, much ornamented at the rings and astragals. On the 1st reinforce, two coats of arms, surmounted with crowns. On the base ring,

'G. Savolhan.'

The catalogue gives the date '1680' for this gun. Length 11′ 7″; calibre 3·75 in.

No. 61 :—

A curious brass gun from Malta. This gun is very much ornamented. The muzzle mouldings are much raised. On the chase, the Maltese cross, letters K K, and symbols.

On the reinforce are the letters K K, and cypher.

F. E. R. T.

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[1] There were two or three knights of the family of De Tresemanes Chastueil Brunot.—*Vide* Boisgellin's 'Malta.'

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These letters, F. E. R. T. are the initials of the words,

'Fortitudo ejus Rhodum tenuit.' His bravery hath held Rhodes.

This was the motto adopted by the successors of the Duke of Savoy after his successful defence of the island of Rhodes against an army of Saracens, A.D. 1311, and hence the Knights of Rhodes, who were afterwards the Knights of Malta, made use of it as a motto.

Underneath these letters there is a shield with a cross in the centre, two lions for supporters. On the vent field, the letters 'M. P.' The breech and cascable are much ornamented: the end of the button resembles an animal's face. The catalogue gives the date 1681 for this gun. Length 12′ 10″; calibre 7 in.

No. 60 :—

A brass gun from Malta, with date 1681. Between the neck astragal and muzzle mouldings there is a Maltese Cross. On the 1st reinforce are ornamental scroll surrounded with a crown. On the base ring,

'Nieport me fecit, Hagæ, 1681.' Nieport made me at the Hague, 1681.

Length 11′ 11″; calibre 5·5 in.; weight 51 cwt. 1·0.

No. 62 :—

A brass gun from Malta. The catalogue gives the date '1681.' It is very much ornamented with fleurs-de-lis, leaves, &c. The dolphins represent fish. On the 1st reinforce there is the figure of a man in strong relief, holding a crosier in his right hand. Under this figure, two shields with the arms, surmounted by a crown. The button represents the face of an animal. Length 16′ 4″; calibre 5 in.; weight 68 cwt. 0·21.

No. 63 :—

A brass gun from Malta. Catalogue gives date '1681.' Much ornamented with fleurs-de-lis, &c. On the 1st reinforce, two coats of arms surmounted with crowns. On 2nd reinforce, the figure of a woman with a palm branch in right hand, the left resting on an altar, having a crown on her head, surmounted with a crescent. Length 8′ 7″; calibre 2·75 in.; weight 10 cwt. 0·0.

No. 64 :—

A brass gun from Malta. Old catalogue gives the date 1688. The gun is much ornamented. On the chase are two fish in a wreath. On 1st reinforce, a scroll enclosing the figure of a pine on a pedestal. On the faces of the trunnions are lions' heads. The dolphins represent fish. The vent is spiked. Length 8′ 6″;' calibre 3 in.

No. 65 :—

A brass gun from Malta, with date 1688. It is much ornamented with double eagles on the chase and 2nd reinforce. On the 1st reinforce there

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is a coat of arms, and under the arms, a scroll with the following inscription,

'M. Mag. Lascaris[1] ad usum triremis suæ,
'Fund. me f.f. 1688.'
The Grand Master Lascari caused me to be cast for use on board his galley.

Length 7′ 6″; calibre 3·5 in.

No. 69 :—

A brass gun from Malta, with date 1728. On the chase, a shield with three crescents, the whole surmounted by an order, chain, and cross. Beneath this a scroll, with the words,

'Fundat^{s}. fr:[2] Raimundi de Veri Majoric.' Cast by brother Raymond de Veri of Majorca.

On the 1st reinforce, two coats of arms under a crown. The arms are two shields; on the one a plain cross, on the other two small crosses in the 1st and 3rd quarters, a winged hand with a dagger in 4th quarter, and a lion rampant in 2nd quarter. A semi-wreath of flowers partly surrounds the two shields. Above them a scroll with the words,

'Pro fide.' For the faith.

On the base ring,

'Petrus Ribot me fecit Bar^{ne}, 1728.'

Length 10′ 9″; calibre 6 in.; weight 58 cwt. 2·13.

No. 72 :—

A brass gun from Malta, with date 1756. On the chase, a winged lion with an open book in its paws (the Venetian arms), beneath which the letter or symbol 'X,' below which again, a coat of arms, all in relief. The 1st reinforce is beautifully ornamented with spiral bars, the 2nd reinforce with fleurs-de-lis and leaves. Close to the 2nd reinforce the inscription,

'M. M. Emanuel Pinto dedit anno domini MDCCLVI.'[3]
Given by the Grand Master Emanuel Pinto, in the year of our Lord, 1756.

On the base ring,

'Le ch. J. B$^{te.}$ Duvand Com$^{re.}$ de l'art$^{rie.}$, 1756.'
The chevalier J. B$^{te.}$ Duvand, Superintendent of the artillery, 1756.

Length 11′ 6″; calibre 5 in.

No. 74 :—

A brass gun from Malta, with date 1769. On the chase, in a scroll, the name of the gun,

'L'animoso.' The courageous.

Then two blank shields. The dolphins represent two branches. On the 1st reinforce, two coats of arms, surmounted with a crown, and surrounded with military supporters. On the base ring,

'Franciscus Trigance f. Tavrini, anno 1769.' Francis Trigance, maker, Turin, in the year 1769.

Length 7′ 1″; calibre 3·25 in.

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[1] There must be a mistake about the date at the end of the inscription, for Lascaris was elected Grand Master in 1638. Caratto was Grand Master in 1688. The inscription in full would be,

'Magnus Magister Lascaris ad usum triremis suæ fundi me fecit, 1688.'

[2] 'Fr.:' frere or frater.

[3] M. M.—Magnus magister. Emanuel Pinto de Fonseca, elected Grand Master in 1741, in succession to Raimond Despig.

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Austrian Guns in the Royal Military Repository.

No. 140 :—

'An Austrian field gun of the 17th century, iron 3-pr.' (*old catalogue*). Length 4′ 2¾″; calibre 3 in.

No. 70[1] : –

An Austrian brass gun with date 1733. On the base ring,

'Fecit Johann Gotteridt Weinholdt a Dresden.'

The cascable represents a pine. The dolphins two females, half-human, half-fish. On the 1st reinforce the Royal Eagle surrounded with a crown; round the neck of the eagle is hung a collar, to which are suspended the initial letters

'A. R.'

connected together. In the right talon a sceptre; in the left a sword of Justice, underneath the date '1733.' The gun is spiked. Length 11′ 3″; calibre 6 in; weight 63 cwt. 1·14.

Danish Guns in the Royal Military Repository.

No. 83 :—

A Danish brass gun, with date 1650. Very handsome. On the base ring,

'Franciscus Roen me fecit Gluckstadt A°. 1650;
Francis Roen made me at Gluckstadt in the year 1650.

On the 1st reinforce a coat of arms within a wreath of olives, and underneath the letters

F . D . G . H . N.
D . S . H . S . D.
C . O . ET . D.

This gun and the following No. 84 were brought from Copenhagen in 1807. Length 9′; calibre 5 in.

No. 84 :—

A brass Danish gun, with date 1683. On the 2nd reinforce a bust of Christian V. surrounded by a belt with these words,

'Christianus V. Dei gratia, Daniæ, Norwegiæ, Vandalorum, Gottorum rex, A°. 1676.'
Christian V. by the grace of God, King of Denmark, Norway, the Vandals, and the Goths, in the year 1676.

On the 1st reinforce 'C. V.' surmounted by a crown, and underneath the date '1683.' On the base ring,

'Assuerus Koster von der Hart me fecit Copenhagen.'

There is an indentation on the gun, where it has been struck by a shot. Length 8′ 10½″; calibre 8 in.

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[1] There is a similar gun amongst those in the Arsenal.

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No. 73 :—

A small Danish brass gun, with date 1761. Two dolphins representing the heads and trunks of elephants. On the 1st reinforce, a coat of arms with the letters

'F. V.'

The whole surmounted with a crown, under which a scroll with the date 1761. On the base ring the name of the maker, 'Fridrics Wœrk.' Length 4′; calibre 3·25 in.; weight 3 cwt. 3·11.

No. 85 :[1]—

A brass gun, Danish. On 2nd reinforce a head in relief surrounded by a wreath; then

'Christianus Septimus rex Den. et Nor. &c.'
Christian 7th, king of Denmark and Norway, &c.

In the wreath are the words

'Gloria ex patriæ amore.'
Glory from the love of one's country.

On the 1st reinforce 'C. VII.' within another wreath. On the base ring the maker's name 'Fridrics Wœrk.' Length 9′; calibre 5·5 in.; weight 12 cwt. 5·72.

No. 80 :—

A brass Danish gun, with date 1802. The dolphins represent elephants' heads and trunks. On the 1st reinforce the letters 'C. R. VII.[2] under a crown. On the base ring the date and maker's name,

'18. Fridrics Wœrk. 02.'

Length 5 ft.; calibre 3·125 in.

Russian Gun.

No. 77 :—

A Russian brass gun. The catalogue gives the date '1786.' The dolphins represent birds. The vent is in rear of the base ring in a kind of lip. On the 1st reinforce, the Royal Eagle of Russia. Length 4′ 5″; calibre 5 in.

Turkish Gun.

No. 79 :—

A brass gun, with date according to the catalogue '1798.' On the chase the Turkish emblem, a star and crescent. On the 2nd reinforce, a coat of arms nearly obliterated. The vent is in rear of the base ring. Length 6′10″; calibre 5·625 in.

Sicilian Gun.

No. 101 :—

A Sicilian iron gun contrived for quick loading, (*old catalogue*). The vent is in rear of the base ring. Length 2′ 10¼″; calibre 3·25 in.

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[1] Date about 1774.
[2] 'C. R. VII.' i.e. Christianus Rex VII.

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From Corfu.

No. 105:—

An 18-in. iron Pierrier from Corfu; 'founded at Bergamo, a city in Venetian Lombardy, A.D. 1684,' (*old catalogue*). Length 4′ 3½″; weight 43 cwt. 2·21

Canadian Gun.

No. 762:[1]—

A wooden cannon used by the Canadian rebels in 1837 and 1838, bound round with four iron hoops, without trunnions or dolphins. It was loaded with buck shot and small pieces of lead.

From Gambia.

No. 980:[1]—

An ancient brass breech-loader, with date. A block of brass, which passes through the gun metal on both sides, takes out at the side of the vent field. The bore extends quite through the cascable; the block when passed through cutting off the communication. The vent is good. The trunnions are handsome, the dolphins resembling porpoises. On the 1st reinforce a coat of arms much obliterated, underneath the date '1650.' On the base ring,

'Conraet Wegt Wœrt me fecit Hagæ.'

This gun is said to have been brought from Gambia, in the present catalogue. Length 4′ 7″; calibre 3 in.

Neapolitan Guns.

No. 88:—

A brass gun, with date 1736. In a scroll on the chase the words

'Real Marine.' Royal Navy.

In another scroll,

'Servatur imperium.'
The empire is preserved.

On the 1st reinforce a large coat of arms with shields containing the arms of France and Portugal. Underneath the arms a collar is suspended with the Orders of the 'Holy Ghost,' the 'Golden Fleece,' and St George,' attached.

On the base ring,

'Hie[us.] Costronouo f. Neapoli. 1736.'
Made at Naples by Hu. Costronouo, 1736.

Length 9′ 6½.

No. 87:—

A brass gun, with date 1745. On chase in a scroll,

'L'Acberonte.'

The remaining inscriptions and ornaments are similar to the last gun, except that the date is 1745. The dolphins resemble dragons. The vent is large. Length 9′ 7″; weight 39 cwt. 1·18.

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[1] In the Rotunda.

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Old English and Foreign Guns, in the Royal Arsenal, Woolwich.

A curious brass gun,[1] brought from Malta, with date 1607. In length 19 ft.; calibre 6 in.; weight 115 cwt. 2·0. It is a very handsome gun; the muzzle mouldings are ornamented with figures of cherubim in relief, all round. On the 2nd reinforce is the representation in relief of the archangle Michael spearing Satan, who is falling backwards. On the 1st reinforce there are three shields; in the first is a cross, in the second a cross and fleurs-de-lis, in the third three crescents. The breech is ornamented in the same way as the muzzle mouldings. On the 1st reinforce is the inscription,

'Ex perpetuo censu super modicæ comitatu fūdato a Frē Raymodo de Veri majoricar, baivlino, anno 1590, facta anno 1607, tēpore magni cōservatoris Frē Michaelis de Lentom, et cōsignata a Frē Raymodo de Berga magno conservatore.'

Made in the year 1607, in the time of the 'Grand Conservator,' Brother Michael de Lentom, out of the perpetual income derived from the estate of Modica, established by Brother Raymond de Veri of Majorca, bailiff, in the year 1590, and registered by Brother Raymond de Berga, 'Grand Conservator.'

This gun is mounted on a very handsome brass carriage, made in the Arsenal.

Russian Guns.

A Russian brass gun, with date 1795. In length 4 ft. ½ in.; calibre 4·75 in.; weight 6 cwt. 0·21. The dolphins are two eagles; the vent is in a sort of lip, in rear of the base ring. The 1st reinforce recedes towards the breech like many of the Russian guns. On the 2nd reinforce ring the date

'1795.'

On the 1st reinforce ring, an inscription in Russian.

A Russian brass gun, taken at the Redan. In length 9′ 4″; calibre 8 in. The vent in a lip, in rear of the base ring. The reinforce receding like the last gun. The chase has been struck by a shot.

Danish Gun.

An iron Danish gun, date about 1774 (imperfect). It is broken off at the chase so that its length and calibre cannot be ascertained. It is much rusted. On reinforce,

'C.R. VII.'

i.e. Christianus Rex VII.

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[1] Facing the entrance gate of the Arsenal.

[2] In full this inscription would be, 'Ex perpetuo censu super modicæ comitatu fundato a frere (or fratre) Raymodo de Veri, majoricarensi, baivlino, anno 1590, facta anno 1607, tempore magni conservatoris frere Michaelis de Lentom, et consignata a frere Raymodo de Berga magno conservatore.'

'*Baivlinus.*' The dignity of 'baivlinus,' or bailiff was a recognised rank amongst the knights as well as that of '*Grand Conservator.*' The duties of the latter related to the conservatory, to the clothing, and to the purchase of all necessary articles, not only for the troops, but the hospital, &c. The dignity of 'Grand Conservator, or 'Draper' belonged to the language of Arragon.

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From Aden.

A large brass gun brought from Aden, without date. In length 18 ft. 8 in.; calibre 9·75 in. The vent is very large. The breech without a cascable, quite flat. Inscriptions in oriental characters on chase and reinforce.

French Guns.

A French brass gun, with date 1756. In length 4′ 10″; calibre 3·75 in.; weight 6 cwt. 0·17. On the chase,

'La Rugissante.' The Roarer.

then

'Ultima ratio regum.' The final argument of kings.

and on the reinforce

'Pluribus nec impar.' Not an unequal match for many.

Then the face of a cherub in strong relief; underneath, a crown and coat of arms. On the base ring,

'A Strasbourg, par J. Berenger, 1756.'

Dolphins representing two fish.

A French brass howitzer, with date 1813. In length 3′ 3¾″; calibre 6 in. On the chase is a crown. On the base ring,

'Metz le 4 X^{bre} 1813.'

Plain dolphins.

A French brass howitzer. In length 3′ 3¾″; calibre 6 in. On the reinforce the letter 'N' in a wreath, and underneath a crown. On the base ring,

'Metz le 23 Frimaire an. 14.'

Plain dolphins.

A brass gun, probably French. In length 5′ 1½″; calibre 4 in.; weight 12 cwt. 0·6. On the reinforce 'J. M.—P.' In scroll underneath 'S. N. Y.' On chase '9.' A patch on the 1st reinforce for a sight, similar to the usual ones used in carbines.

Austrian Gun.[1]

A brass Austrian gun, with date 1733. In length 11′ 1″; calibre 6 in.; weight 62 cwt. 1·14. The vent is spiked. The cascable represents a pine-apple. The dolphins two figures of women. On the reinforce the Austrian Eagle and 'A. R.'; then the date '1733.' On the base ring,

'Fecit Johann Gottfridt Weinholdt a Dresden.'

Dutch Guns.

A Dutch brass gun, date 1774. In length 5′ 4″; calibre 3·75 in. On the 1st reinforce a coat of arms under a crown, with lion rampant. Motto round it

'Vigilate Deo confidentes.'
Watch ye, trusting in God.

[1] There is similar gun to this in the Royal Military Repository. *Vide* p. 181.

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On the base ring,

'Joh. Maritz fec. Hagæ A° 1774.'
Made by John Maritz at the Hague, in the year 1774.

A brass gun, with date 1720. In length 7′ 7½″; calibre 2·75 in.

On the base ring,

'Me fecit Jan Albert de Grave, Amsterodami, anno 1720.'
Jan Albert de Grave made me at Amsterdam, in the year 1720.

Dolphins representing two fish.

Two 4¼ in. brass mortars. Extreme length 10½ in.
Underneath 'La Motte.' The mortars are chambered. (See Fig. 8).

From the Mauritius.

A small brass 7½ in. mortar and bed, brought from the Mauritius. In length about 16 in. Without date or device. One plain dolphin.

A brass 7½ in. mortar, and bed. Length about 15 in. On chase 'Rohan.' Round the bed,

'Barcelona 4 Decembre, 179—.'
'Cobre de America.'
'P°. C°. 180 L°.'

One plain dolphin.

Seven Guns from Borneo.

1. A brass gun without date, brought from Borneo (with others). In length 7′ 4½″; calibre 3·5 in. The vent is much enlarged from firing. The gun is curiously and handsomely ornamented. There were originally four rings on the gun, now there are three; two on the reinforce, and one on the chase. The other on the chase has been broken off. Their use was probably to raise or move the gun by.

2. Another brass gun from Borneo, without date. Curiously and handsomely ornamented. Dolphins representing fish. The external surface as far as the trunnions is octagonal. Length 8′ 3″; calibre 3·5 in.

3. A curious brass gun from Borneo, without date. Length 4′ 11″; calibre 1·5 in. Circumference of the gun just below the swell of the muzzle, 10 in.; at the reinforce, at the vent, 15 in. Circumference of the swell of the muzzle, 20 in. There is a ball in the bore. A support is fastened under the trunnions, upon which the gun would be elevated or depressed. (See Fig. 9).

4. A brass gun from Borneo, without date. Length 8 ft.; calibre 7 in. There is a coat of arms on the chase. The vent is spiked. Four rings on the gun; two on the reinforce, and two on the chase, for moving the gun.

5. Another brass gun from Borneo, without date. Length 9 ft.; calibre 2 in. The same support underneath the trunnions as on the last gun but one.

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6. A brass gun from Borneo, without date, very handsomely ornamented. Length 5′ 11″; calibre 1·75 in. Dolphins representing two fish.

7. A brass gun from Borneo, without date. Length 7′; calibre 3·75 in. A coat of arms on the reinforce. Dolphins representing fish. The vent is at a great inclination.

English Guns.[1]

A brass gun, with date 1719. In length 6 ft.; calibre 2·375 in.; weight 4 cwt. 2·21. On the chase in relief, a shield with lion rampant, surrounded by the motto, 'Honi soit,' &c., the whole resting on the double eagle. A crown above the eagle. On the 1st reinforce the royal arms, and mottoes.

On base ring,

'A Schalch, fecit, 1717.'

Dolphins representing two fish.

A brass gun, with date 1739. Length 9 ft.; calibre 4·75 in.; weight 29 cwt. 2·19. On 1st reinforce, royal arms and mottoes. On base ring,

'Schalch, fecit, 1739.'

The vent is spiked. Dolphins representing fish.

A brass gun, with date 1748. In length 5′ 6″; calibre 6 in. On the 2nd reinforce the letter 'M'[2] under a coronet. On the 1st reinforce 'G. R.' under a crown. On base ring,

'J. & H. King fec. 1748.'

A brass gun, with date 1759. In length 6′ 5″; calibre 4·425 in.; weight 21 cwt. 1·9 On the chase a star, then a coronet with coat of arms underneath; and in a scroll the motto,

'Aut nunquam tentes, aut perfice.'
Either never make an attempt, or accomplish it.

Then the inscription,

'The Right Honourable George Sackville, Lt.-General, and the rest of the principal officers of His Majesty's Ordnance.'

On the 1st reinforce the royal arms and mottoes. On the base ring,

'W. Bowen, fecit, 1759.

Dolphins representing fish.

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[1] The English guns here enumerated are none of them very old. They are preserved, I believe, rather as mementoes of the rise and growth of the Gun Factory Department in the Arsenal.

[2] 'M' must be the initial letter of the name of the then Master-General.

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Two brass guns, with date 1774. Length 7′ 11″; calibre 3·75 in. weight of 1st, 19 cwt. 3·26; of 2nd, 19 cwt. 2·6. On the chase the arms and motto of the family of Townshend underneath a coronet; the motto is

'Hæc generi incrementa fides.'
Fidelity hath won these honors for our race.

On the 1st reinforce the royal arms and mottoes. On base ring,

'J. & P. Verbruggen, fecerunt, A°. 1774.'

Dolphins representing fish.

A brass gun, with date 1776. Length 5′ 10½″; calibre 2·25 in.; weight 3 cwt. 0·24. On 1st reinforce, a crown and the letters 'G. R.' underneath the date '1766.' On base ring,

'J. & P. Verbruggen f^t.'[1]

This gun is rifled with two grooves.

A brass gun, with date 1777. Length 5′ 11″; calibre 3·625 in.; weight 19 cwt. 0·18. On the chase under a coronet the arms and motto of the Townshend family. The motto is,

'Hæc generi incrementa fides.'
Fidelity hath won these honors for our race.'

On the reinforce the royal arms and mottoes. On base ring,

'J. & P. Verbruggen, fecerunt, A°. 1777.'

Dolphins representing fish.

A brass gun, with date 1778. In length 5′; calibre 3·75 in.; weight 10 cwt. 0·20. This gun is exactly similar to the last in its ornaments, arms, and mottoes. The date only is different, being 1778. There is a tangent scale, attached to this gun.

A brass gun, with date 1779. In length 4′ 6″; calibre 3.75 in.; weight 5 cwt. 0·19. On the chase a coronet with the letter 'T' (i.e. Townshend). On base ring,

'J. & P. Verbruggen, fecerunt, A°. 1779.

On reinforce 'G. R.' under a crown.

A brass gun, with date 1780. In length 5′; calibre 2 in.; weight 2 cwt. 2·11. On the chase the letter 'T' for the M. G. the Marquis Townsend. On reinforce 'G. R.' and a crown. On base ring,

'J. & P. Verbruggen, fecerunt, A°. 1780.

Two brass howitzers, with date 1780. In length 3′ 11″; calibre 10 in.; weight of 1st, 25 cwt. 3·8.; of 2nd, 25 cwt. 2·0. On the chase the royal arms, crown, and mottoes. On the reinforce a coronet with the letter 'T' On base ring,

'J. & P. Verbruggen, fecerunt, A°. 1780.

Dolphins representing fish.

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[1] ft. i.e. fecerunt.

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A brass gun, with date 1783. In length 7′, calibre 3·625 in., weight 12 cwt. 1·20. On the chase, a coat of arms under a coronet, 'Honi soit,' &c. round in a scroll. Underneath in another scroll, the motto of the Richmond family,

'En la rose je fleuris.' I flourish in the rose.

Royal arms, crown, and mottoes on the 1st reinforce. On base ring,

'J. & P. Verbruggen, fecerunt, A°. 1783.

Dolphins representing fish.

Two brass howitzers without date, but probably about the same as the last gun. Length 2′ 3″, calibre 4·5 in., weight 5 cwt. 1·6. On the muzzle mouldings the inscription,

'Arva tueri.' To protect the fields.'

On the chase the royal arms, crown, and mottoes, Underneath in a scroll the motto of the Richmond family.

'En la rose je fleuris.' I flourish in the rose.

Two brass guns, with date 1785. Length 4′ 6″, calibre 3·25. in., weight of 1st, 7 cwt. 3·3; of 2nd, 7 cwt. 2·25. On the chase a coat of arms, coronet, and motto, 'Honi soit,' &c. round it. On 2nd reinforce the royal arms, motto, and crown. On 1st reinforce royal arms and crown supported by two human figures, men, with clubs in their hands. On base ring,

'P. Verbruggen Voolvici in Angliâ, fudit, A°. 1785.'
Crst by P. Verbruggen at Woolwich in England, in the year 1785.

A brass gun, with date 1797. In length 6 ft., calibre 3 in., weight 6 cwt. 0·24. On the muzzle mouldings the inscription,

'Arva tueri.' To protect the fields.

On the 1st reinforce a coat of arms, coronet, and motto, 'Honi soit,' &c. Underneath in a scroll, the motto of the Richmond family,

'En la rose je fleuris.'

On base ring,

'J. & H. King, 1797.'

Two brass guns, with dates 1801. Length 4′ 10″, calibre of 1st, 3 in.; of 2nd, 2·75 in. On chase the letter 'C' under a coronet with the motto, 'Honi soit,' &c. round it. On 2nd reinforce a group of suits of armoury, standards, &c., in relief. On 1st reinforce the royal arms and mottoes. On vent field, the date '1801.' On base ring, 'J. & H. King.' There is a wreath of flowers half round the gun, just below the 2nd reinforce.

A brass gun, with date 1805. Length 6′ 11″, calibre 3·75 in. This gun is similar to the last two guns in ornaments and inscriptions, except the date '1805.' It has plain dolphins and tangent scale.

A brass gun without date. Length 4′ 7″, calibre 3 in. It is similar to the last gun in ornaments, &c.

A brass gun without date. Length 3′ 10″, calibre 3 in. Similar to the last gun in everything else.

A brass gun without date. Length 6′, calibre 3 in. A modern English gun without date, ornament, or device.

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A brass gun without date. Length 6′; calibre 3·625 in. A plain gun. On the reinforce 'G. R.' under a crown, the motto, 'Honi soit,' &c. round it.

A brass gun without date. Length 6′ 10½″, calibre 2 in. A perfectly plain piece without trunnions or dolphins. A piece of metal is attached underneath the gun extending about half its length, with two holes in the part nearest the centre of the piece. (See Fig. 10).

A brass howitzer without date, with its carriage. In length 2′ 8¾″, calibre 6 in.

A brass mortar without date. Extreme length 30 in., calibre 8 in. There is no date or inscription. It is curious from having a small hole, about two inches in circumference, through the metal at the end of the bore.

A brass mortar without date or inscription. Extreme length about 15 in., calibre 7·5 in.

A brass mortar and bed. Length about 16 in., calibre 8 in., weight 2 cwt. 2·26. On the piece the letters 'G. R.' and a crown.

An imperfect fragment of an iron gun, broken off above the trunnions. The fracture shews the gun to have been made in two distinct parts. The bore being formed by a cylinder, over which a kind of jacket of metal has been cast. Calibre about 3·5 in.

Another fragment of an iron gun, imperfect, being simply a part of the muzzle. It is handsomely and elaborately worked.

In the Royal Artillery Institution, Woolwich.

There is a curious iron gun, at present lying in the Institution, in length 3 ft., calibre 2 in. A printed card on the gun states that 'it was taken off the old Genoese castle at Yenikale. It is supposed to have been left there by the Genoese, when the Crimea came into the possession of the Russians in the 16th century. It was presented to the Royal Artillery Institution by Colonel Dickson, C.B., R.A.

Five guns on the Parade in front of the Artillery Barracks, Woolwich.

Four of them are Florentine brass guns, very handsome. In length 11 ft., calibre 6 in. The chase, muzzle mouldings, and 1st reinforce, are more especially ornamented. The dolphins represent fish. The date of these guns would be about 1745.[1] On the chase in a scroll, in relief, is the name of the gun, 'Violentum.' Underneath a handsome group of armour.

In a second scroll on the chase the inscription,

'Tutor et ultor.'
The protector and avenger.

[1] The inscription on these guns gives the name of Francis, Duke of Lorraine, &c. He married Maria Theresa of Austria, and through this connection became Emperor of Austria in 1745 to 1765. Hence the date of these guns with the name of Francis, could not be earlier than 1745.

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On the 1st reinforce in a scroll,

'Et adhuc spes durat avorum.'
Even still lasts the hope of our ancestors.

Then underneath a crown, the double eagle supporting a coat of arms, and then the inscription,

'Franciscus Rom. Imp. rex. Germ. et Hier. dux Lot. et Bar. mag. dux Etruriæ.'[1]
Francis, Emperor of the Romans, King of the Germans and of Jerusalem, duke of Lorraine and Bar, Grand Duke of Tuscany.

On the base ring,

'Filii Andreæ Moreni, fecerunt, Florentiæ.'
The sons of Andreas Morenus, makers, Florence.

These four Florentine guns are exactly similar to each other, with the exception of the first scroll on the chase, which gives the name apparently of each gun. On the others are,

2. 'Testudo.'[2]
3. 'Destructor.'
4. 'Negans.'

in place of 'Violentum,' in No. 1.

The fifth gun on the Parade is the celebrated Indian brass gun. In length 14′ 6″, calibre 9 in.; thickness of metal at muzzle 7 in. This enormous brass gun was captured at Burtpore.

Guns in the Tower of London,

At present lying in front of the *White Tower.*

English Guns.

One of the wrought-iron serpent guns, the date of a similar one in the catalogue for the Royal Military Repository, Woolwich, is 1422, or the beginning of the reign of Henry VI. The gun is not complete, there is a detached piece with it, which probably formed the breech. It is made of longitudinal bars of iron hooped together with iron rings. The calibre is about 7 in., but the whole gun is so much eaten away with rust that it is impossible to ascertain it accurately. On the muzzle mouldings is a piece of iron raised. (See Fig. 11).

Another 'serpent' wrought-iron gun, probably about the same date as the last. It was recovered A.D. 1545, from the wreck of the 'Mary Rose,' which was sunk in an action with a French vessel in 'Ports-mouth' harbour. There is a stone shot in the bore, with which the gun must have been loaded when the vessel went down. Length about 11′ 6″, calibre 6 in.

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[1] This inscription in full would be: 'Franciscus Romanorum imperator, rex Germanorum et Hierosolymæ, dux Lotharingiæ et Barensis, magnus dux Etruriæ.'

[2] '*Testudo*' was the name of an ancient military engine; a kind of portable shed, under cover of which the besiegers of a town could advance in comparative safety close up to the walls.

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A part of a wrought-iron 'serpent,' probably about the same date as the last.

Two iron chambers for guns called 'peteraras,' date probably about 1450, or a little earlier.

A 'peterara' of wrought-iron. In length 3′ 10″, calibre 3 in. Date 1461, probably the same as that assigned in the catalogue to the peterara in the Repository at Woolwich (See Fig. 1.), or the beginning of Edward IV. reign. It has no chamber.

A peterara of brass, probably about the same date as the last, 1461. Its present length is about 2 ft., but it is imperfect. It was injured by the fire in the Tower of London in 1841, and has had a large piece broken, or burnt off, at the muzzle. (See Fig. 12).

It differs from the iron peterara, in that the receptacle for the chamber is not hollow underneath; the chamber being merely supported by a band in the iron gun (Fig. 1.), whereas, in the brass gun, it is simply as if a slot had been cut out of the reinforce for the chamber. The handle or trail *x*, *y* is of iron. The external surface of the piece is perfectly smooth, and unlike the iron peterara, which has bands of metal round it.

A brass gun of 7 in. calibre. A metal plate attached to the gun, states that it was 'of the time of Henry VII. A.D. 1486,' and was formerly 13 ft. long, but reduced by the fire in 1841 to 4′ 6″. There is a fleur-de-lis on the chase, and underneath the royal arms of England, but very much obliterated. (See Fig. 13).

A brass gun with date 1520. In length 7′ 9″; calibre 2·625 in. It is of the time of Henry VIII. (the date '1520' being on a metal plate attached to the gun). The exterior surface is *octagonal*. The vent is large and much worn away.

A brass gun, with date 1520. In length 7′ 7″; calibre 2·375 in. Of the time of Henry VIII. (the date '1520' being on a metal plate attached to the gun). The exterior surface is *octagonal*. The vent is large, and worn away.

A flat brass cannon, very curious, with three bores.[1] The date '1520' is given on a metal plate on the gun. There are receptacles at the reinforce for three chambers, each similar to a peterara. It has been so much injured by the fire in 1841, being now broken into four pieces, that it is impossible to ascertain its length. The calibre is 2 in. The shape of the face of the muzzle being shewn in Fig 14.

On the muzzle mouldings are the words,

'Pour defendre.' To defend.

On the 2nd reinforce, in relief, a crown and rose, supported by two children with branches in their hands. Then the inscription,

'Henricus Octavus, Dei gratiâ, Anglie et Francie rex, fidei Defensor, Dñs. Hibernie.'

Henry VIII. by the grace of God, King of England and France, Defender of the Faith, Lord of Ireland.

[1] For note on Pierre Baude, and on this gun in particular, see introductory remarks.

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Then underneath,

'Petrus Bavde Gallus, operis artifex.'
Peter Bavde, a Frenchman, manufacturer of the work.

A brass gun of the time of Henry VIII., with date 1542. A metal plate on the gun states that it weighed 'upwards of five tons, and was believed to have been used in the "Great Harry;" it was called the "cannon of eight" (its calibre being 8 in.)' Its length has been reduced by the fire in 1841. The dolphins are still on the gun. On the 1st reinforce, and underneath a rose and crown in relief, is the inscription,

'Henricus VIII. Anglie, Francie, et Hibernie rex fidei defensor invictissimus f.f. 1542.'
Henry VIII., King of England, France, and Ireland, invincible Defender of the Faith, caused this to be made, 1542.

A brass gun, with date 1546. A metal plate on the gun states that it was of the time of Henry VIII., and was anciently called 'cannon of seven' (i.e. calibre 7 in.). Calibre 7 in.; length 11′ 6″. On the 1st reinforce, the rose and crown, and the motto 'Honi soit,' &c. round it. Underneath the rose, the inscription,

'Henricus Octavus Dei Gratiâ, Anglie, Francie, et Hibernie rex, fidei defensor, et in terrâ ecclesiæ Anglicane et Hibernice supremum caput.'
Henry VIII., by the grace of God, King of England, France, and Ireland, Defender of the Faith, and, on earth, supreme head of the English and Irish church.

Under this,

'Thomas Emeur Knight was Master of the Kyng's Ordnance whan John and Robert Owen,[1] brethren, made this pece. Anno Domini 1546.'

A brass gun, with date 1549, of the time of Edward VI. In length 6′ 7″; calibre 2·75 in. On the 1st reinforce,

'Caresebrowke.'

On 2nd reinforce,

'Robert and John Owine, brithrine, mad this facone, anno 1549.'

The vent is good.

A brass gun, with date 1601, of Queen Elizabeth's time. In length 9′; calibre 3·75 in. This gun was captured by the Chinese from the natives of Cochin China, as appears from Mr Hewit's (see *Official Catalogue of Tower Armouries*) translation of the Chinese inscription on the chase, as follows :—

'The members of the Military Board and Governor of Che Keang province, and the General of the Army, We-yeun-wan, have caused this gun, which was obtained at Soo-fuh-che-le to be tried, to ascertain that it was perfect and worth preserving. * * * It is Tahshin's adorned tribute from his victory over the Cochin Chinese. Twice used, it is found to be a cannon of good workmanship, and of intimidating power. This inscription is engraved according to the usual forms.'

And on the base ring,

'The general in command of the army, with the officers and troops, by the favor of heaven, obtained and used it.'

[1] For note on the Owens,' see introductory remarks, p. 156.

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This gun was retaken by the British at Chusan in 1842. A blank shield on 2nd reinforce. On 1st reinforce,

'Richard Phillips made this pece. Año Dñi 1601.'

The vent is much enlarged.

A brass gun, with date 1672, of the time of Charles II. In length 4′ 5¾″; calibre 4·25 in.; weight 19 cwt. 2·21. There is a great, but gradual increase in thickness of metal towards the breech. The trunnions are peculiarly small. Length of trunnions 3¾ in.; diameter 4 in. The vent is good and clear. On the face of the muzzle,

'C . R . 1672.' (i.e. Carolus Rex) 1672.

A brass mortar of the date 1686, and time of James II. In length 1′ 11″; calibre about 7½-in., but the muzzle is much injured from the effects of the fire in 1841. On the chase, 'J . R' under a crown. On the reinforce,

'Jacobus II. Mag. Brit. Fra. et Hib. rex. anno regni sui secundo.'
James II. King of Great Britain, France, and Ireland, in the second year of his reign.
'Dñs. Georgius Legge, Baro de Dartmouth rei tormentariæ bellicæ præfectus generalis.'
Lord George Legge, Baron Dartmouth, Master-General of the Ordnance.[1]

A brass 18-in. mortar of William III. reign, date 1692, used by him at the siege of Namur, in 1695. The original bed was destroyed by the fire in 1841, but the ironwork being recovered, the bed was restored by the Royal Carriage Department, at Woolwich. In length 3′ 9″; weight 66 cwt. 2·4. On the reinforce the inscription,

'Gulielmus et Maria Mag. Brit. Fra. et Hib. rex et regina, anno regni quarto.'
William and Mary, King and Queen of Great Britain, France, and Ireland, in the 4th year of their reign.

Then,

'By the Right Hon^ble. S^r. Henry Goodricke Knt. Bart. Lieut.-Gen., and the rest of the principal officers of their Majesty's ordnance.'

A crown with 'W . M' on chase. Two dolphins representing fish. The vent in a kind of lip.[2]

An iron gun, recovered from the wreck of the 'Edgar,' 1841 (ship of the line), after having been 132 years under water. This ship blew up off Spithead, in 1711, with all her crew on board, just after a service in North America. 900 lives were lost. The gun was recovered by diving operations in 1841. A rose and crown on 2nd reinforce. The whole gun is very much eaten away with rust. Length 9′ 9″; calibre 6·75 in.; weight 51 cwt. 0·14.

An iron gun, recovered in 1834 from the wreck of the 'Royal George,' which sunk at Spithead 19th August, 1782. All lives were lost, including Admiral Kempenfelt. The gun is very much rusted. 'G . R' on the 2nd reinforce. Length 9′ 10″; calibre 6·75 in.; weight 56 cwt. 2·16.

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[1] Lord Dartmouth was M. G. from 1681–1689.

[2] Mr Hewit states that this mortar was presented to the crown by the officers named in the inscription.

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A brass gun, also recovered from 'the Royal George.' The cascable is broken off. The dolphins represent porpoises. The royal arms and mottoes on the 1st reinforce. On the chase, the arms and motto of the family of Shannon. The motto is,

'Spectemur agendo.'[1] Let us be judged by our actions.

Length 9′ 6″; calibre 6 in.

A curious brass mortar with nine bores. Calibre 7·25 in.; weight 47 cwt. 3·14. A metal plate attached to it states that it was intended to discharge nine shells at once.[2] The bores are chambered. There are three vents, each one serving for three bores. (See Fig. 15).

An iron carronade. In length 4′ 2″; calibre 8 in.; weight 30 cwt. 3·23. A metal plate on the gun, states this to be 'one of the first castings of the gun called carronade.' The crest of the Duke of Atholl on the reinforce. The vent is stopped up. There is a raised piece of metal for laying the gun.

An iron 'ship gun.' Length 9′ 4″; calibre 7·25 in.; weight 65 cwt. 1·18. The letters 'G . R' on the reinforce.

Two iron cannons, without date, removed from Ireland in 1849, and deposited in the Tower by request of Colonel Dundas, inspector of artillery.

Length 10′; { calibre of 1st, 6·25 in.; weight 52 cwt. 2·24.
„ 2nd, 6 in. „ 53 „ 8·21.

French Guns in the Tower of London.

Two 13½-in. brass mortars, with dates 1683 and 1684, captured at Cherbourg 1758. On the chase the inscription,

'Non solis radios, sed Jovis fulmina, mitto.'
I throw not the rays of Sol (the sun), but the thunderbolts of Jove.

Then a coat of arms with a cross in the shield, and on the reinforce the arms of France. A lip for the vent resting on a human face. One dolphin formed by two fish joined together. Under the vent,

'Kelleri Helvetii, fec., Duaci 1683.'
Keller the Swiss, maker, Douay 1683.[3]

The mortars are quite similar, except that the date on one is 1684.

Two brass cannon, triple bore, taken at Ramillies in 1706, by the Duke of Marlborough. They are much injured by the fire in 1841.

Length of 1st, 3′ 10″; calibre cannot be ascertained, the muzzle being so much injured by the fire.

Length of 2nd, 6′; calibre 4·75 in.

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[1] The motto 'Honi soit,' &c. surrounds the arms; the family motto 'Spectemur agendo' is in a scroll underneath.

[2] Mr Hewit states that this mortar 'was used at the rejoicings at the peace of Aix la Chapelle in 1748, for discharging fireballs and other fireworks,' and also refers to Britton's memoirs of the Tower, p. 268.

[3] 'John Balthasar Keller, the Swiss founder, was a very celebrated worker in metal in his day, and among other productions cast a very fine statue of Louis XIV. in 1692; he died in 1702.'—Mr Hewit.

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The name of one gun on the chase appears to be,

'Les volcanoes.'

That on the other gun is quite obliterated. Then,

'Louis Auguste duc du Maine,'

who was a natural son of Louis XIV.; and underneath this,

'Ultima ratio regum.' The final argument of kings.

On the 2nd reinforce,

'Pluribus nec impar.' And not an unequal match for numbers.

Then a coat of arms with fleurs-de-lis in the shield. The whole under a crown. Dolphins representing porpoises. The two guns are alike in ornaments and inscriptions.[1]

Two brass cannon, with date 1748, taken at Cherbourg.

Length } of both { 10′ 7″
Calibre } of both { 6 in.

(1) On chase the name of the gun,

'Le Temeraire.' The bold.

Then,

'Ultima ratio regum.' The final argument of kings.

Then,

'Louis Charles de Bourbon,"
'Comte d'Eu,'
'Duc d'Aumale.'

Then a crown with a shield under, with fleurs-de-lis, supported by two field guns. On 2nd reinforce,

'Nec pluribus impar.' Not an unequal match for many.

Then a crown, a coat of arms with fleurs-de-lis again, the whole with military supporters underneath. On the base ring,

'Fondu à Douay le 15 Mars 1748, par Jean Maritz.'
Cast at Douay, 15 March, 1748, by Jean Maritz.

(2) On the chase, 'Charles,' instead of the 'Le Temeraire.' The rest like the last gun, No. 1. On the vent field,

'Strasbourg, MDCCXLVI.'

On base ring,

'Fondu par Jean Maritz, commissaire des fontes de l'Art^{rie}.'
Cast by Jean Maritz, superintendent of the foundries of artillery.

The vents of both guns are at the extremity of a small pan, which extends down the reinforce. The breeches of both are faces of men with the cascable protruding out of their mouths.

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[1] These pieces are thus described by Père Daniel, in his *History of the French Army*. 'The invention,' he tells us, 'was that of an Italian monk: the three shots were to be discharged at the same time; the first sample was cast at Paris, others were subsequently founded at Douay.'—Mr Hewit.

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A brass 13-in. mortar, with date 1750, belonging to the French company of merchants trading to the East Indies. In length 3 ft. On the chase the inscription,

'La Campagnie des Indes de France.' [1]
The French East India Company.

On the breech just above the trunnions,

'Fait par Gor à Paris, 1750.'

The mortar is chambered. Dolphins handsome. The lip, in which is the vent, resting on a human face.

A brass gun, with date 1778. In length 10′ 2½″; calibre 5·125 in. On the reinforce a crown, and underneath it two letters 'L' joined together.

On the base ring,

'Strasbourg le 3 Juillet 1778 par I. de Dartein, Ecuyer, Commiss^re General des fontes de l'art^rie.'
Strasbourg, July 3rd, 1778, by I. de Dartein, Equerry and chief Superintendent of the foundries of the artillery.

Plain dolphins on the gun,

Two iron ship guns, stated to have been taken from the French, by Lord Howe, A.D. 1794. Length of 1st, 9′ 9″; calibre 7 in.; of 2nd, 9′ 8″; calibre 7 in.

Two brass 12-in. mortars captured at St Jean d'Arc 1799. Length of 1st, 3′ 1″; of 2nd, 2′ 10″. On the chase

'Liberté Egalité,'

and underneath,

'A. N.'

These mortars were brought to England by Captain Sir Sydney Smith. There is but one dolphin on No. 1, and two on No. 2.

French Guns.

A brass gun, with date 1806, captured in the French Prame, 'Ville de Lyon,' one of the Boulogne flotilla, 1811. Length 8′ 3″; calibre 6 in. On the chase the inscription,

'La Victoire.'

On 1st reinforce a crown, then a wreath of flowers with the letter 'N' (i.e. Napoleon) within it. On base ring,

'Fondu à Avignon, par le Sieur Capon le 9 Mars, 1806.'

A brass 13-in. mortar, of Napoleon's time. Length about 3′ 6′. On the chase the letter 'N' (Napoleon) underneath a crown, and within a wreath of flowers. One plain dolphin.

[1] There is a gun in the Horse Armoury with the same inscription.

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An iron gun, of the time of the French Republic. This gun was brought from the Mauritius. Length 8′ 3″; calibre 4·5 in. On the 1st reinforce the cap of Liberty.

Gun of the Knights of St John (or of Malta).

A brass gun without date, brought from Malta, 1838. Length 16′; calibre 5 in.; weight 71 cwt 3·0. This gun is very much ornamented with fluers-de-lis, &c. On the 1st reinforce the figure of St John in strong relief holding a banneret with a cross on it. Underneath two shields, one with a plain cross on it, the other with crosses and fleurs-de-lis in opposite quarters.

Venetian brass gun from the Havannah,

Said to have been brought to England by Admiral Vernon, having been captured at the Havannah in 1762. It is a Venetian gun, and has the Venetian arms on the 1st reinforce; the figure of a winged lion with open book in its right paw, (i.e. the lion of St Mark). The gun was injured at the muzzle by the fire in 1841. Length 8′; calibre 4′ 5″.

Spanish and Portuguese Guns.

A brass gun. In length 13′ 4″ originally, but reduced by the fire in 1841 to 10′; calibre 4·5 in. A metal plate on the gun states that it formerly belonged to Charles V. of Spain, A.D. 1509. The muzzle mouldings ornamented with a human figure in relief. On the chase a large shield with, first, the representation of two castles; then two ships, and the figure of a large fish in the water. Underneath the words,

'LAFVETESYENPRELEAL
DELACORONAREAL
CASTRODEVRDIAIES.

Dolphins representing two fish.

Brass 13-in. mortar, with date 1724. In length 2′ 10½″. On the chase underneath a crown,

'Ludovicus Hispan. rex.'
Louis, King of Spain.[1]

Then

'Vole à Abet, fecit, Saville A.D. 1724.'

One dolphin formed by the union of two fish. The vent is on a kind of lip, which rests on a human head. The mortar is chambered.

A brass gun (Spanish) with date 1778.[2] In length 9′ 5″; calibre 5·125 in. On the chase,

'Arion.'

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[1] In 1724 Philip V. resigned the crown to his son Louis, who held it for about a year, and then died. It was resumed by Philip,

[2] Mr Hewit says this gun was taken from the Chinese in 1842.

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On the 1st reinforce ring,

'Par à Plasa.'

On 1st reinforce under a crown,

'C. R. 3.' i.e. Carolus rex III.

On base ring,

'Barcelona 29 d'Octobre de 1778.'

A brass gun, date assigned by metal plate on the gun is 1581. Length 7′ 9¾″; calibre 4·75 in. It has an iron chamber, and is stated to have been 'obtained by purchase.' There is a coat of arms on the chase, much obliterated. The gun is open from the 1st reinforce ring to the breech, and the iron chamber put in by means of a ring or handle. A square hole on each side of the breech, apparently to fasten the chamber in the gun.

A brass gun, with date 1594. This Portuguese gun was taken at Hyderabad, in 1843. In length 12′ 9″; calibre 7·125 in.; weight 81 cwt. 2·10. On the chase in strong relief, a representation of the Virgin and Child, and underneath on either side figures of two of the apostles, apparently St Peter and St John. The figure on the left of the Virgin with two keys in one hand, and a book in the other. The other figure with sword in left hand, and a book in the right. Under these figures the words,

'DA CIDADE DE CHAVI.'

From the city of Chavi.

On the 1st reinforce,

'A.D. 1594.'

There are four loops on the gun for rings, and three rings.

Two brass guns, with date 1627, captured in China in 1841.

Length of No. 1, 10′ 2¾″; calibre 8·75 in.
„ No. 2, 11′ 1″; „ 10·75 in.

On the 2nd reinforce of both, a coat of arms. Then a cross surrounded by the words,

'DA CIDADE DO NOME DE DEOS DA CHINA.'

From the city of the name of the gods of China.

The city of the gods (Deos) being equivalent to the Chinese word 'Macao.' Then underneath,

'MANOEL TAVARES BO'
'CARRO AFES A. 1627.'

On No. 2, the larger gun, the coat of arms, supported by two winged human figures. The cascable of both somewhat the form of a sheep's head. There is a similar gun in the Royal Military Repository at Woolwich.

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Two brass guns, date about 1640, taken at Vigo by the forces under command of Lord Cobham, 1704. Length of both 9′ 7″; calibre 6 in. The muzzle mouldings are handsome. On the chase in relief, the figure of the Virgin with palm branches in her hand, and underneath are the words,

'Sancta Barbara.'[1]
'Catholicis Barbaris.'
Revered by Catholics, unknown amongst barbarians.

'Barbari' being all, except 'Catholici.' Lower down, on the chase,

'Philippo IV. Catholico.'[2]
For Philip IV. the Catholic.

Then a large coat of arms, underneath a crown. On the 2nd reinforce ring, the words,

'Parcere subjectis.' To spare the conquered.

On the 1st reinforce underneath a shield with a lion rampant and bar across, on it, the words,

'Le Mareschal Cantelmo, grand maistre de l'artillerie.'

The breech is curiously formed, representing as it were the form of a lion, or rather the hide of a lion, thrown over the rear part of the gun. The head is laid nearly flat on the surface of the reinforce; the forepaws on each side, and a little raised so as to form a handle to raise the gun. The hind haunches are shewn on the sides of the breech, and the hind legs and paws stretch a little underneath. The cascable is formed by the tail, which is curled so as to make a loop. On one of the two guns, the name of the founder is on the lion's tail,

'An. Cavthais, me fudit.'

Turkish Guns.

A brass gun, with date 1530. Length 17′ 1″; calibre 9 in. On chase in oriental characters, but translated on a plate fastened on the gun,

'This cannon was made by command of the Sultan Solyman, son of Selim, for an invasion of India in the year of the Hegira 937.' A.D. 1530.

It was captured at Aden, January, 1839, by the expedition under command of Capt. H. Smith, C.B., of H. M. Ship 'Volga'. An inscription in oriental characters on 1st reinforce, and translated as

'Mahomed, son of Hamzat Allah.'

The vent is large.

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[1] Mr Hewit says that the figure is that of Saint Barbara, and therefore that the inscription 'Sancta Barbara,' 'Catholicis Barbaris,' refers to her.

[2] Philip IV. King of Spain and Portugal, 1621–1665. In 1640 Portugal revolted from Spain, and gained her independence; therefore, if this is a Portuguese gun, and not Spanish, its date is between 1621 and 1640. If a Spanish gun, between 1621 and 1655.

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A brass gun, with date 1769. An inscription in oriental characters on reinforce in strong relief, but translated on metal plate thus,

'The work of the Sultan Ranafa Achmet Modigemed, Deen of the country of Palambang the sacred; on which be peace. 1183 of the Hegira.' A.D. 1769.

Length of gun 14′; calibre 7 in.; weight 73 cwt. 1·11. This gun was taken in Java in 1811. The dolphins are large and represent fish.

Dutch Guns.

Two brass guns, with dates 1734 and 1738. Length of both 10′ 1¾″; calibre 4·75 in. 'Taken by storm on the batteries within the lines of Cornelis on the island of Java, 26 August, 1811.' This memo. is cut on the 1st reinforce under the coat of arms mentioned below, and just above the vent there is also the inscription,

'To H.R.H. the Prince Regent, hereby presented with every sentiment of respect and duty in the name of the captors, Robt. Rollo Gillespie, Col. Commanding in Java.'

The dolphins on both, though injured by the fire in 1841, are handsome. On the 1st reinforce in strong relief a coat of arms, a shield with a lion rampant; round it in a scroll the motto,

'Vigilate Deo confidentes.'
Watch ye, trusting in God.

So far both guns are alike; the only difference is in the inscription on the base ring. On the first,

'Me fecit Cornelis Crans, Hagæ A° 1748.'

On the second,

'Me fecit Adrianus Crans, Hagæ A° 1734.'

Asiatic Gun.

A brass gun without date, but from its appearance probably very ancient. A metal plate states it to be 'An Asiatic gun.' Oriental characters on the chase and 1st reinforce. The vent is enlarged. There is no cascable, simply a knob. Length 6′ 5″; calibre 4 in.

Chinese Guns.

Two iron guns without date, brought from the Bogue Forts, in China, 1841, as ballast in a merchant ship.

Length of No. 1, 4′ 1″; calibre 3·5 in.
„ No. 2, 5′ 2″; calibre 3·75 in.

On No. 1, there is an inscription in Chinese characters on the chase. The bore is much eaten away, the vent enlarged.

On No. 2, the cascable and trunnions are broken off; the vent enlarged.

A brass gun without date. Length 9′ 9″; calibre 4·5 in. It was captured in China. There is an inscription in Chinese on the 2nd reinforce. It was added to the collection at the Tower by the H.E.I.C.S. in 1856.

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Russian Guns.

A brass gun,[1] with date 1789 on 2nd reinforce. Length 4′ 5″; calibre 5 in. It was captured in a Turkish frigate. The dolphins represent eagles; one of them has been injured by the fire in 1841. The imperial eagle on the 1st reinforce. The vent in a lip in rear of the base ring.

An iron gun without date. This is a cast-iron Russian gun, having the imperial eagle on it. In Length 6′ 10″; calibre 3·75 in.

Danish Gun.

An iron gun, date between 1766—1808. Length 6′ 3″; calibre 3·75 in. The bore is much injured by the fire in 1841. The dolphins represent fish. On the 1st reinforce, under a crown,

'C. R. VII.' i.e. Christianus rex VII.[2]

Mortars from Corfu, and the Ionian Isles.

Two cast-iron sea service mortars with their beds, 13·25 in. calibre, with spherical chambers, presented to the Board of Ordnance by the Ionian Government. Length about 3′ 6″.

Two 'Schulemberg[3] pierriers of cast-iron for projecting stones,' 18-in. calibre, from Corfu. They are embossed with the lion of St Mark. On the reinforce,

'MDCLXXXIV.'
'T. W.'

Indian Guns.

A brass gun, of the date 1664. Length 9′ 9″; calibre 5·75 in.; weight 60 cwt. Inscription in Indian characters on the chase, two reinforces, and base ring. The gun is designated,

'Hatelo Lashk^{n}.' Victory.

This gun was cast at Ahmednugger by Mahomed Hussein in the year of the Hegira 1075, A.D. 1664, and found in the fort of Ahmednugger on its capture in 1803. The dolphins represent porpoises. The vent enlarged from firing. Vent fittings for a clasp to cover the vent, still left.

A brass gun without date. In length 7′ 10″; calibre 2·5 in.; found like the last one at the same place and time. The cascable is broken off, and the vent spiked. There is a grotesque head painted in red on the muzzle. The vent is in an iron patch about 1½ in. broad and 3½ in. long.

An iron gun without date. Length 9′ 7″; calibre 4·25 in.; weight 10 cwt. This is a curious specimen of an old Indian gun. There are grotesque figures painted in red on the muzzle. It was found like the last two at Ahmednugger. There are four bands or rings of iron round the gun,

[1] There is a gun similar to this in the Royal Military Repository.

[2] Metal plate on gun states this to be a 'Danish gun.' Christian VII. reigned over Denmark from 1766 to 1808.

[3] 'The Count of Schulemberg was generalissimo of the Venetian troops in 1716, and gained great renown by his heroic defence of Corfu against the Turks.'—Mr Hewit.

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with three loops in them, to pass rings through. The gun is very much rusted.

A very curious Indian brass mortar, calibre 9·5 in., without date. In length about 3′ 9″. Externally it represents the form of a tiger sitting on its haunches; the tail being curled over the back. The bore is chambered. It was found in the fort of Kurnaul.

A brass gun found in the fort of Kurnaul, without date. Length 9′ 1″; calibre 5·5 inches. The head of a tiger at the muzzle. The trunnions and cascable are very handsome, with heads like that on the muzzle. The whole gun is much ornamented. The vent apparently has never been drilled.

A brass gun without date, taken at Candabar in 1842. Length 4′ 2″; calibre 3·75 in.; weight 5 cwt. 2·14. It is elaborately ornamented. Two figures of animals like bull dogs recumbent on the 2nd reinforce. An inscription in oriental characters on 1st reinforce.

A brass gun without date, captured at Burtpore. Length 11′ 3½″; calibre 3·75 in.; weight 67 cwt. It has an *iron bore*,[1] about 1½ in. thick, and much rusted. The gun is very handsome, especially the muzzle mouldings, reinforce rings, base rings, and cascable. Inscription on chase and 2nd reinforce in oriental characters. A patch on the base ring with a groove in it to lay the gun by.

A brass gun without date, captured from Scindia at the battle of Argaum in November, 1803. It was known at Ahmednugger as Scindia's field howitzer. Length 3′ 6″; calibre 5 in.; weight 6 cwt. 3·18. There is an inscription on 2nd reinforce in oriental characters.

An iron gun, curiously formed, resembling in shape the two in the Royal Military Repository, at Woolwich (see p. 172). It is flat in form and bore. Total length 2′ 1″; weight 4 cwt. Length of the face of muzzle 1′ 3½″; depth 2¾″. It was captured at Bhoof in 1819.

Miscellaneous Guns.

Two brass guns, cast at Woolwich from ordnance taken at Cherbourg, 1758, highly ornamented, but injured by the fire in 1841.[2] The royal arms, mottoes, and supporters on the reinforce and chase. Length of both 9′ 9″; calibre 6 in.; weight of one 54 cwt. 2·8. On the base ring of the other,

'W. Bowen, fecit, 1762. W. Collins, sculpt.'

Miscellaneous Guns deposited at the Armoury in the Tower.

A brass cannon, most elaborately and beautifully ornamented with leaves, arms, shields, and busts in relief. The trail of the wooden limber is formed of the twining together of two human figures. This gun was put on board the French ship of war 'La Sensible,' by the French forces under General Buonaparte in 1778, and carried to Egypt. 'La Sensible' having escaped the action in Aboukir bay, took shelter in Malta, and after having been

[1] It is like an iron cylinder with a jacket of brass.

[2] These two guns are on field carriages on the parade at the Tower.

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confined in that harbour by the English blockading squadron, again escaped; but being met on her way to France by the 'Sea Horse,' English frigate, commanded by Captain Foote, was captured with this gun on board, which was ordered to be deposited in the Tower. On the face of the muzzle is the inscription,

'Et pompâ et usu.' For both show and use.

On the chase,

'1773.'

Then,

'Philip Lattarellius Pom. delin. et sculp.'

On the 1st reinforce,

'Terreni fulmina Martis.'
The thunderbolts of the mortal Mars.

Then,

'Le C. de Boyer D'Argens Com.'

On base ring,

'Horatius Antonius Albergh,' &c.

Two very handsome brass guns, captured at Quebec. 7 feet long; 2·525 in. calibre. On the chase, round the figure of a serpent gazing at the sun, is the motto,

'Vires dum respicit, auget.'
Whilst it looks, it grows in strength.

Above this the representation of another serpent gliding along the ground, and the inscription,

'Nil sistit euntem.'
Nothing stops its progress.

There is another serpent on a shield on the reinforce.

Eight brass cannon, 9-prs., captured at Waterloo. The names of the guns are on their chases.

'Le Cigne, L'Amerique, Le Guebre, La Suffisante, Le Fameux, L'Etonnant, L'Achille, L'Ohio.'

Two howitzers, about 12-prs, also taken at Waterloo.

Brass 12-pr. also captured at Waterloo. Letter 'N' (Napoleon) on the reinforce.

A small brass cannon made at Woolwich for the young Duke of Gloster, son of Princess afterwards Queen Anne, mounted on a field carriage, 1698. On the 2nd reinforce,

'Quo fata vocant.' Wherever fate calls.

A small brass cannon similarly mounted, but the carriage destroyed and the gun injured by the fire in 1841.

A brass cannon, much ornamented, from Affghanistan. Length 6 ft.; calibre 3·75 in.

A brass gun from the Mauritius. Length 4 ft.; calibre 2 in.

A brass 'yacht' cannon, one of the set which formed the armament of a model frigate, built for and presented to the king of Denmark, at the time the Danish fleet was removed from Copenhagen in 1801. This frigate was left by the English: was afterwards sent to England by the Danes, with the message 'that they had imagined it had been left in mistake.'

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Sketched by Major Miller, R.A.

Lith.d at the Topographical Depôt by J. Ferguson

TOWER, CONVENT & CEMETERY OF SOLFERINO

From the South West.

7th May 1859.

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A STUDY

OF THE

ITALIAN CAMPAIGN

IN 1859.

CHAPTER I.

INTRODUCTORY.

THE country in which the active part of the campaign took place lies between Turin and Mantua, and may be described in general terms as a plain 90 miles long by 30 broad, the Po forming its southern boundary.

It is crossed from north to south by several rivers, which join themselves to the Po. Commencing on the west, the principal are the Dora Baltea, Sesia, Agogna, Ticino, Lambro, Adda, Oglio, Mella, Chiese, and Mincio.

The Dora Baltea is 20 miles from Turin; the Sesia flows past Vercelli; the Agogna is a little west of Novara; the Ticino is the boundary between Lombardy and Piedmont from the Lago Maggiore to the Po; the Lambro is three miles east of Milan; the Adda issues from the east arm of the Lake of Como, flows past Lodi and joins the Po near Cremona; the Oglio, from the Lake of Iseo, takes first a southerly, then a south-easterly course, and joins the Po at Borgoforte, between Parma and Mantua; the Mella and Chiese join the Oglio; the former leaves Brescia two miles to the east; the latter is ten miles nearer to the Lake of Garda; the Mincio runs out of the Lake of Garda at Peschiera, and passes Mantua a little before it joins the Po.

The above description will be sufficient to identify the rivers in any small atlas which may give the course without printing the name of each.

These, like all other short rivers supplied from mountains, are very empty in summer, with wide gravelly beds; sometimes two or three channels and islands between; banks steep on the concave, and shelving on the convex side of the turns. The Po is considerably larger than any of its tributaries; at Valenza, below its See Plate 15.

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junction with the Sesia, the winter stream is 550 yards across, and there was no masonry bridge below Casale until railways were carried across it within the last few years. One of these is at Valenza, field works and batteries were thrown up on the west side to defend its passage, but the other end was unprotected, and occupied for a short time by the Austrian forces. The Casale bridge is covered by a strong permanent fortification, which, by securing the passage of the river to the Allies, had a considerable influence on the campaign.

See Plate, No. 15.

Tracts of marshy ground, thick with bushes and trees, border the Po on each side, and the embankments, made to preserve the country from inundations, have caused its bed to raise itself above the original level.

Spurs from the Apennine range run up to the main road from Novi to Piacenza, and along the south side of the river from Valenza to Turin; between them and the Alps on the north side of the plain, the country is peculiarly flat.

The land is very closely cultivated for vine, corn, and rice crops, and is intersected in every direction with irrigating channels, which are often obstacles of importance in a military point of view. There are generally belts of trees and bushes by the side of the streams; but the most remarkable feature is, that the whole country is like one vast orchard, planted closely with young fruit trees, which, not being allowed to grow to any size, shoot out thickly and impede the view in every direction. This quite prevents artillery from being used to advantage, or masses of cavalry employed. When, as is often the case, vines grow between the rows of trees, even infantry move with difficulty. As, however, there are few fences, and those not so thick or close as to be impassable, brigades can generally deploy in any direction.

Villages are numerous, and outside each is a cemetery, which was generally the scene of hard fighting, if the place was attacked. All the cemeteries are alike: square enclosures, with walls from eight feet to fifteen feet high, entered by an iron gate with a grated opening on each side of it.

See Frontispiece.

The detached farmhouses usually receive the name Cascina (literally cow-house), with some addition to distinguish it; such as "Cascina Dado," "Cascina Nuova," &c. It follows in consequence that "Cascina Nuova" is as common a name for a farm in Lombardy, as the "New Inn" for a public-house in England.

The roads are of three classes: 1st, "Strade reale," or "postale," royal or post roads; 2d, "Strade provinciale," country roads; 3d, "Strade communale," by-roads.

The first are excellent; they are about the width of turnpike-roads in England, macadamized, and run quite straight, sometimes for miles together.

The second are good roads, but the third are mere tracks, and soon become impassable in bad weather or with much traffic.

Most of the railroads are at present only single lines. As they are not all shown on the maps, it is necessary to remark that

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there are (amongst others) railways between the following places:—

In Piedmont, running East and West—
Susa, Turin - - { Vercelli, Novara, the Ticino.
Alessandria, Tortona, Voghera, Piacenza.
Running North and South—
Genoa, Novi, Acqui - Alessandria, Valenza { Casale, Vercelli, Mortara.
Novara, Arona (on the Lago Maggiore.)

The Austrians tore up the rails and destroyed bridges on the lines which they met with in their advance to the Dora Baltea, and their incursions towards Tortona. The damages were, however, repaired as soon as they retired, and the communications had been re-opened in time to make use of them when the allied army was ready for the field.

The Austrians had on their side two railways from Verona to the frontier: one to the Lake of Como, the other to the Ticino at Magenta. Verona was connected with their other dominions by two lines: one northerly to the Tyrol by the valley of the Adige; one easterly to Venice and further towards Trieste, but only completed as far as Udine.

Also, there was a third line from Verona, southerly, to Mantua, Modena, and Bologna, at all which places there were Austrian garrisons.

THE ARMIES ENGAGED.

To describe the entire organization of the armies, including non-combatants as well as combatants, would require much more time and a much freer access to information than are at my disposal; but it is desirable to understand how the infantry, cavalry, and artillery were brought into the field, in order to comprehend the the movements of the campaign.

French Army.

The French army serving in Italy consisted of the following troops:—

Infantry—

Imperial Guard	Gens d'armes (probably for camp duties)	1 regiment.
	Grenadiers	3 „
	Voltigeurs	4 „
	Zouaves	1 „
	Chasseurs	1 battalion.
Line		49 regiments.
Zouaves		3 „
Algerian rifles (Turcos)		1 „
Foreign regiments		1 „
Chasseurs (light infantry)		10 battalions.

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All the regiments, except the Zouaves of the Imperial Guard (2 battalions), had 3 battalions each in the field, averaging 800 strong. The Chasseur battalions numbered 1,200 each.

Cavalry—

Imperial Guard (Cuirassiers, Dragoons, Lancers, Chasseurs, and Guides)	6 regiments.
Light Cavalry (Lancers, Chasseurs, and Hussars)	12 „

The French line cavalry is divided into three classes; of the heavy (Carbineers and Cuirassiers), there were none in Italy; of the next class (Dragoons and Lancers), only one regiment of the latter. The number of horses is different for each class; for the heavy regiments 1,282; for the line 1,352; for the light 1,422 horses. This is the war establishment; in peace they have about 800. Each regiment is subdivided into 6 squadrons, 12 divisions, 24 pelotons, 48 sections.

Artillery.—In batteries of 6 guns each, armed as far as possible with the new rifled 4-pounder gun. The weight of this gun is 5¾ cwt., of the projectile 8½ lbs., and of the charge 1 lb. 2 oz. It is said to fire with accuracy up to 3,300 yards range (3,100 mètres).

A French division contains 4 line regiments and a battalion of Chasseurs; sometimes a regiment of Zouaves in place of the latter. It is divided into 2 brigades, each furnished with a battery of 6 guns.

Besides the field batteries of a division, it is intended that each infantry regiment shall have a proportion of the new rifled guns (probably two to a battalion) worked by its own men, and drawn by two horses furnished from the Lancer regiments. How far this came into operation during the present campaign does not appear.

A corps contained two or three divisions, with some light cavalry (generally two regiments) and a reserve artillery of 18 guns; a General of Artillery was on the staff of each.

The Cavalry of the Guard formed a separate division in itself, and the Line Cavalry regiments attached to the various corps were collected into two divisions before the battle of Solferino.

Sardinian Army.

The Sardinian, or Piedmontese Army, as it is more commonly called by foreign writers, was all employed in this war. It consists of—

Infantry.—20 regiments of the line, divided into 4 small battalions of 700 each (for the field); 10 battalions of Bersaglieri, or Riflemen, each employed separately, and about 1,000 strong, on a war footing.

Cavalry.—4 heavy, 5 light regiments of 4 squadrons; each squadron containing about 150 mounted men.

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Artillery.—In batteries of 8 pieces, 6 guns (generally 6-pounders), and 2 howitzers.

Two infantry regiments form a brigade, which receives a name from the district in which it is raised. Two of these brigades, with two batteries and some light cavalry, composed a division; and five of these divisions, with a division of the heavy cavalry, make up the whole army.

Austrian Army.

The Austrian infantry regiments are exceedingly strong, and bring into the field four battalions of 1,200 each. The troops which correspond to the Chasseurs and Bersaglieri are the "Grenzer" or Borderers (so called from being originally raised on the Turkish frontier), and the Jägers (Rangers).

At the end of June the Austrian army on the Mincio contained—

			Proper Strength.
Infantry	Line regiments, battalions	148	
	Grenzer and Jäger battalions	31	
		179	= 214,000 men.
Cavalry	Heavy Dragoons, squadrons	24	
	Light — Uhlans (Lancers) squadrons	28	
	Light — Hussars	36	
		88	= 16,000 men.
Artillery	Batteries of 8 pieces (6 guns, 2 howitzers,) some 6-pounder, some 12-pounder guns	102	= 20,000 men.
			250,000

The heavy cavalry regiments have 1,017 horses in 3 divisions of 2 squadrons each. The light cavalry regiments have 1,596 horses in 4 divisions. Squadrons of the former have therefore 170, and of the latter 200 horses.

One infantry regiment, with a battalion of Grenzers, or Jägers, and a field battery, was the usual formation of a brigade. Two, sometimes three, brigades and a detachment of light cavalry (about 4 squadrons) formed a division.

A corps properly contained two of these divisions, a reserve brigade of 4 battalions, 8 squadrons, and 8 guns; and further, a reserve artillery of 40 guns.

Moreover, to every army of 4 corps, there was added a grand artillery reserve of 20 batteries, 160 guns.

The force on the Mincio comprised two complete armies and 37 brigades; it ought, therefore, to have had the enormous number

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of 1,000 field guns. At Solferino, 102 batteries are said to have been available, but only 45 (360 guns) engaged; this was at the rate of one battery to each infantry brigade there, and two reserve batteries to each corps.

Generally speaking, then, a brigade, division, or corps in each army represented a combatant force as follows:—

	Austrian.	French.	Sardinian.
Brigade	5 battalions of 1,200. 8 guns. 6,200 men.	6 battalions of 800. 6 guns. 5,000 men.	9 battalions of 700. 8 guns. 6,500 men.
Division	10 battalions. 4 squadrons (200.) 16 guns. 13,200 men.	13 battalions. 6 squadrons, (200.) 12 guns. 12,000 men.	18 battalions. 4 squadrons, (150.) 16 guns. 13,600 men.
Corps	24 battalions - 28,800 men. 16 squadrons - 3,200 „ 88 guns - - 2,200 „ 34,200	39 battalions - 31,200 men. 12 squadrons - 2,400 „ 54 guns - - 1,400 „ 35,000	

Of course, the establishment of a regiment is hardly kept up for the first ten days of a campaign; but unless one side suffers much more than the other from sickness or casualties in action, the above numbers would fairly express the *relative* strength throughout.

Non-combatant forces, such as Medical, Commissariat, and Transport Corps, are omitted from all the numerical estimates; it is almost impossible to learn their exact numbers; and as they have to be deducted from the strength of forces in action, they only cause confusion by being introduced. It may be mentioned, however, that they would increase a corps from 34,000 to 40,000 men.

Lists of the Regiments.

The following lists of the regiments which were brigaded together, and the generals who commanded them, will be found useful for reference in studying other accounts of the war, as well as this. They are taken from M. Rüstow's work, corrected by comparing it with other narratives.

The letters G.C.B. and K.C.B. after the generals' names, show that they are Knights of the Bath for service in the Crimea.

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French Army.

General Commanding in Chief.—The Emperor Napoleon III. (aged 51.)

Imperial Guard: 27 Battalions, 36 Squadrons.

General Regnaud de St. Jean d'Angely, G.C.B. (aged 64), made a Marshal at Magenta.

- Mellinet
  - Cler (Killed at Magenta)
    - Zouaves — 2 Battalions.
    - Gens d'Armes — 3 (Not engaged in any action.)
    - 1st Grenadiers — 3 Battalions.
  - Wimpffen
    - 2d „ — 3 „
    - 3d „ — 3 „
- Camou, K.C.B.
  - Manéque
    - Chasseurs — 1 „
    - 1st Voltigeurs — 3 „
    - 2d „ — 3 „
  - Decaen (Succeeded Espinasse).
    - 3d „ — 3 „
    - 4th „ — 3 „

Cavalry Division.

- Morris, G.C.B.
  - Marion
    - 1st Cuirassiers — 6 Squadrons.
    - 2d „ — 6 „
  - Champeron
    - Dragoons — 6 „
    - Lancers — 6 „
  - Cassaignolles
    - Chasseurs — 6 „
    - Guides — 6 „

Ist Corps: 41 Battalions, 12 Squadrons.

Marshal Count Baraguay d'Hilliers (aged 64), made a Marshal for the capture of Bomarsund, 1854.

- Forey
  - Beuret (Killed at Montebello)
    - 17th Chasseurs — 1 Battalion.
    - 74th Line — 3 „
    - 84th „ — 3 „
  - Blanchard
    - 91st „ — 3 „
    - 98th „ — 3 „
- L'Admirault
  - Martimprey
    - 10th Chasseurs — 1
    - 15th Line — 3
    - 60th „ — 3 (These are doubtful.)
  - Ladreidt de la Charriére
    - 81st „ — 3
    - 100th „ — 3
- Bazaine
  - Gose
    - 1st Zouaves — 3 Battalions.
    - 33rd Line — 3 „
    - 34th „ — 3 „
  - —
    - 37th „ — 3 „
    - 78th „ — 3 „
- Cavalry
  - 5th Hussars — 6 Squadrons.
  - 1st Chasseurs d'Afrique — 6 „

IId Corps: 25 Battalions, 12 Squadrons.

General Count M'Mahon, G.C.B. (aged 52), created Duke of Magenta.

- De la Motte Rouge
  - Lefebvre
    - Algerian Tirailleurs — 3 Battalions.
    - 45th Line — 3 „
  - De Bonnet Maurelhan de Polhes
    - 65th „ — 3 „
    - 70th „ — 3 „
- Espinasse (Killed at Magenta, succeeded by De Caen)
  - —
    - 14th Chasseurs — 1 „
    - 71st Line — 3 „
    - 72d „ — 3 „
  - De Castagny
    - 2d Zouaves — 3 „
    - 2d Foreign Regiment — 3 „
- Cavalry
  - 4th Chasseurs à Cheval — 6 Squadrons.
  - 7th „ — 6 „

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III^rd Corps: 39 Battalions, 24 Squadrons.

Marshal Canrobert, G.C.B. (aged 50), former Commander-in-Chief in the Crimea.

Bourbaki	Vergé	18th Chasseurs	1	Battalion.
		11th Line	3	„
		14th „	3	„
	Ducrot	46th „	3	„
		59th „	3	„
Trochu	Bataille	19th Chasseurs	1	„
		43d Line	3	„
		44th „	3	„
	Collineau	64th „	3	„
		88th „	3	„
Renault	Piccard	8th Chasseurs	1	„
		23d Line	3	„
		41st „	3	„
	Jannin	56th „	3	„
		90th „	3	„

Cavalry.

Montaubau	1st Brigade	6th Hussars	6	Squadrons.
		2d „	6	„
	2d „	7th „	6	„
		8th „	6	„

IV^th Corps: 39 Batalions, 12 Squadrons.

General Niel, G.C.B., promoted Marshal at Solferino (aged 57).

Vinoy	Niol	6th Chasseurs	1	Battalion.
		85th Line	3	„
		86th „	3	„
	De Leyritz	21st „	3	(doubtful).
		75th „	3	„
De Failly	O'Farrel	15th Chasseurs	1	Battalions.
		52d Line	3	„
		53d „	3	„
	Saurin	55th „	3	„
		76th „	3	„
De Luzy Pelisac	Douay	5th Chasseurs	1	„
		30th Line	3	„
		49th „	3	„
	Le Noble	6th „	3	„
		8th „	3	„
	Cavalry	2d Chasseurs à Cheval	6	Squadrons.
		10th „	6	„

V^th Corps: 28 Batalions, 12 Squadrons.

Prince Napoleon Buonaparte.

D'Autemarre, K.C.B.	- - -	3d Zouaves	3	Battalions.
		83d Line	3	„
		89th „	3	„
	- - -	93d „	3	„
		99th „	3	„
Uhrich	- - -	1st Chasseurs	1	„
		18th Line	3	„
		26th „	3	„
	- - -	80th „	3	„
		82d „	3	„
	Cavalry	4th Lancers	6	Squadrons.
		8th Hussars	6	„

Total of the French army in Italy, 15 divisions; containing 199 battalions, 108 squadrons, and 288 guns; or in numbers, 162,000 infantry, 21,000 cavalry, 7,000 artillery: 190,000 combatant men.

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SARDINIAN ARMY.

General Commanding-in-Chief—KING VICTOR EMMANUEL.

1st Division, Lieut.-General Castelborgo, (afterwards Durando.)	Grenadier	1st Grenadiers	4	Battalions.
		2d „	4	„
	Savoy	1st Infantry	4	„
		2d „	4	„
	Bersaglieri	3rd Battalion	1	„
		4th „	1	„
2d Division, Lieut.-General Fanti.	Piedmont	3d Infantry	4	Battalions.
		4th „	4	„
	Aosta	5th „	4	„
		6th „	4	„
	Bersaglieri	1st Battalion	1	„
		9th „	1	„
	Cavalry	Novara	4	Squadrons.
		Aosta	4	„
3d Division, Lieut.-General Durando, K.C.B., (afterwards Mollard.)	Cuneo	7th Infantry	4	Battalions.
		8th „	4	„
	Pinerolo	13th „	4	„
		14th „	4	„
	Bersaglieri	2d Battalion	1	„
		10th „	1	„
	Cavalry	Alessandria	2	Squadrons.
4th Division, Major-General Cialdini.	Regina	9th Infantry	4	Battalions.
		10th „	4	„
	Savona	15th „	4	„
		16th „	4	„
	Bersaglieri	6th Battalion	1	„
		7th „	1	„
	Cavalry	Montferrat	4	Squadrons.
5th Division, Major-General Cucchiari.	Casale	11th Infantry	4	Battalions.
		12th „	4	„
	Acqui	17th „	4	„
		18th „	4	„
	Bersaglieri	5th Battalion	1	„
		8th „	1	„
	Cavalry	Alessandria	2	Squadrons.
		Saluzzo	4	„
Heavy Cavalry Division, General Sambrey.	Nizza		4	Squadrons.
	Piedmont		4	„
	Savoy		4	„
	Genoa		4	„

Total combatant force, 20 regiments, 10 battalions of Bersaglieri, 36 squadrons, and about 90 guns: equal to 74,000 men.

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Austrian Army.

No complete list is given of the Austrian brigades in the early part of the campaign; as far as can be ascertained, they were composed thus:—

Commander-in-Chief—Feldzeugmeister Count Gyulai (aged 61).

- **I^st Corps (arrived at Milan 1st June): Lieut. Field Marshal Count Clam Gallas.**
  - Cordon
    - - - - Wernhardt.
    - - - - Archduke Ernest.
  - Montenuovo
    - Rezniczek
      - Archduke Joseph.
      - 1st Grenzer Battalion.
    - Burdina (died of wounds at Magenta).
      - Prince Wasa.
      - 2d Jäger Battalion.
- **II^d Corps: Lieut. Field Marshal Prince Edward Liechtenstein.**
  - Jellachich
    - Szabo
      - Archduke William.
      - 7th Jäger Battalion.
    - Kudelka
      - Hesse.
      - 21st Jägers.
  - Herdy
    - Baltin
      - Hartmann.
      - 16th Jägers.
    - Kintzl - - - Archduke Sigismund.
- **III^d Corps: Lieut. Field Marshal Prince Edmund Schwarzenberg.**
  - - - -
    - Ramming
      - King Leopold of Belgium.
      - 23d Jägers.
    - Hartung - Archduke Lewis.
  - - - -
    - Dürfeld - - Prince Edward Liechtenstein.
    - Wetzlar
      - Archduke Stephen.
      - 15th Jägers.
- **V^th Corps: Lieut. Field Marshal Count Stadion.**
  - Paumgarten
    - Gaal
      - Archduke Charles.
      - 1 Battalion Grenzer.
    - Bils - - Zobel.
    - Hesse -
      - Culoz.
      - 6th Kaiser Jägers.
- **VII^th Corps: Lieut. Field Marshal Thomas Von Zobel (aged 60).**
  - Reischach
    - Gablentz
      - Grüber.
      - 3d Jägers.
    - Lebzeltern - Emperor Francis Joseph.
  - Lilia -
    - Weigl -
      - Archduke Leopold.
      - 19th Jägers.
    - Dondorf - Wimpffen.
- **VIII^th Corps: Lieut. Field Marshal Lewis Von Benedek (aged 55).**
  - Berger
    - Boer - - Crown Prince Albert of Saxony.
    - Roden - -
- **IX^th Corps,: General Count Schaafgottsche.**
  - Crenneville - Braum - - Rossbach.
  - Urban - Schaafgottsche
    - Don Miguel.
    - 3d Jägers.

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CHAPTER II.

FROM THE OPENING OF THE CAMPAIGN TO THE BATTLE OF MONTEBELLO.

THE first hint of a war had been given at the Tuileries by Louis Napoleon's speech to the Austrian Ambassador, on the 1st January 1859. All the three powers concerned pushed forward their preparations, though France made only such as she could excuse without betraying warlike intentions. Her newly-invented arms had to be made, and fresh ammunition prepared for them. An alteration in the infantry drill, from formations of three deep to two deep, required smaller battalions, which necessitated a fresh organization, and increase in their number. Finally, the stores in general were below the proper peace establishment, and must be brought up to it.

Piedmont brought her distant troops out of Sardinia and Savoy, and assembled her army near the Lombardy frontier. Reserves were called out, volunteers from other Italian States were invited to join her ranks, and all the fortifications were armed and strengthened.

Austria at once sent a corps out of Vienna to join the three already in Italy. Two more followed in the course of April. Negociations were carried on for three months; but she had little faith in their success, and relied more on her well-appointed army than on the result of mediation.

Napoleon was resolved on a war, but found convenience in the delay, his preparations not being so far advanced as he could wish to see them. Victor Emmanuel had only waited for such a helping hand, to cope with his hereditary foe. The ultimatum from Austria was presented on the 23d April; it was rejected on the 26th, and on the 29th her forces crossed the Ticino.

This movement opened the campaign, unless a previous advance of French troops into Savoy on the 25th April be considered to have done so. Three trains, each containing two battalions (1,600 men) passed Chambery that afternoon, on their way to St. Jean de Maurienne; six more were to follow on the 26th. Thus, the first infringement of existing treaties came really from France, but Napoleon well knew that war would break out in a day or two, and some hours saved might prove of great importance. No harm could ensue, as the circumstance would not be known until its political importance was gone.

The IInd, IIIrd, Vth, VIIth, VIIIth, and IXth Austrian Corps were between Pavia and the Lago Maggiore before their irruption into Lombardy. Six corps represent 205,000 fighting men; but the troops at Parma, Modena, Ancona, and elsewhere in the Legations

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were furnished from these. Piacenza, Pavia, and other places had to be garrisoned, and therefore 24 brigades, or 150,000 men, would probably represent the moveable strength of the army.

At any rate, it was double that of the Piedmontese, who fell back on the defences they had prepared. Alessandria and Casale were permanently fortified; the rest were principally field works which they had constructed for the occasion.

To besiege them at Alessandria was out of the question. The Austrians might occupy Turin, or hold the country towards Genoa, and hinder their junction with the French; always bearing in mind that the latter were advancing from the north as well as the south, and that a retreat must eventually be necessary. That the country should be held long under the circumstances, and against a constantly increasing army, was not to be expected.

The latter movement promised a better result in a military point of view; on the other hand, there was the prestige, with all its indirect advantages, of occupying the enemy's capital.

On the 1st May the passage of the Ticino was completed, and the situations of the two armies were as follows:—

See Plan, No. 1.

Austrian Army.—On the left bank of the Agogna, with its left thrown back along the north bank of the Po to Pavia and Piacenza. Head-Quarters at Lomello.

Sardinian Army.—Right wing on the south bank of the Po, from Alessandria to Casale. Left wing along the Dora Baltea, covering Turin. Head-Quarters at Occimiano, between Casale and Valenza.

French Army.—Ist Corps at Genoa; IIIrd Corps at Susa and Turin; IVth crossing the Alps, and the remainder on their way to Genoa.

As there is steam communication by land and water all the way from Paris to Alessandria by the route of Marseilles and Toulon, the French Emperor was able to send troops into Piedmont on that side with unexampled rapidity. Some regiments were transferred from Paris to Genoa in five days. On the other side, there were difficulties to contend with, arising from the railway between Chambery and Susa being open only to St. Jean de Maurienne. This left a march of at least forty miles to be performed on foot over a pass still encumbered with the winter snow. Four thousand workmen were employed on the road to make it passable. The diligence takes fourteen hours to do this distance in summer; but the cavalry, artillery, and even some of the infantry, are said to have performed it in one day's march.

On the 2d May the Austrians continued their advance. Vercelli was occupied by Zobel's Corps; detachments pushed forward to Trino, Pobiesto, Gattinara, and Biella, and on the 8th their outposts were in sight of Ivrea on the Dora Baltea.

On the left a bridge was thrown over the Po at Cornale, and an Austrian column, crossing it on the 3d, penetrated as far as Tortona, but retired again on the 6th, after destroying the railway-

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bridge at Pontecurone, near Voghera. Whilst it was on the right bank, an unexpected rising of the river carried away the bridge at Cornale, and its communication with the main body was for a time cut off.

In the centre, demonstrations were made of crossing the river at Valenza, Frasinetto, and Casale, which led to some sharp skirmishes.

The Sardinians were now withdrawn from the Dora Baltea, by Canrobert's advice, to join the main body at Alessandria. The direct defence of Turin was given up. Only a few squadrons of cavalry were between the capital and the enemy, and its safety depended on what weight Gyulai might attach to the gathering force on his left flank. The Dora Baltea line, strengthened as it was by all the art of the Sardinian engineers, was abandoned.

On the 9th May the positions were:— See Plan, No. 2.

AUSTRIAN:

IInd, IIIrd, and VIIth Corps near St. Germano on the roads to Turin and Ivrea. Vth Corps, from Stroppiana to Candia, watching Casale and the Po. VIIIth, along the north bank of the Po, east and west of Pavia. IXth, at Piacenza. Head-quarters at Vercelli.

SARDINIAN:

1st Division at Occimiano, 2nd at Alessandria, 3rd and 4th principally at Casale, and along the Po to Valenza; 5th Division at Novi.

FRENCH:

Ist Corps at Novi, and further south. IInd at Valenza. IIIrd and IVth (from Mont Cenis) at Alessandria. Imperial Guard on the march between Genoa and Alessandria.

GARIBALDI, with his irregular corps of 4,000 men, at Biella.

Although the French army was now nearly complete in infantry, it was very deficient in cavalry and artillery, which did not arrive in any important numbers until the second fortnight of May. On the 18th batteries were still arriving at Turin. The Artillery of the Guard did not leave Genoa till the 15th May, and regiments of light cavalry were then disembarking. The Emperor was still at Paris, and postponed his departure till the army was ready to receive him.

The change above described in the Austrian position, together with their blowing up the railway bridge at Valenza on the 7th, which secured their flank and prevented the Sardinians from crossing without the aid of pontoons, seemed to indicate that an advance upon Turin was decided; but at this point the Austrian arrangements were suddenly changed. A report reached Gyulai that the Allies were about to act vigorously in the direction of Piacenza. Immediately on its receipt, he withdrew the troops by a forced march from St. Germano to Vercelli, and the left side of the Sesia; strengthened his left wing, and prepared for the rumoured attack. See Plate, No. 15.

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For the next ten days, however, nothing particular occurred. He established his head-quarters at Mortara, and Lieutenant Field Marshal Urban, with a flying column, moved about the country towards Voghera. A military bridge at Vaccarizza, just below Pavia, gave a communication with the south side of the Po.

On the 19th, Gyulai, still anxious about his left wing, withdrew Zobel's corps from Vercelli to Robbio, blowing up two arches of the railway and road bridge over the Sesia. He also shifted his head-quarters to Garlasco, nearer Pavia, and arranged that reconnaissance in force, which was carried out the following day, and resulted in the battle of Montebello.

See Plate, No. 3.

The Austrians now occupied a triangle, of which the Sesia and Po, from Vercelli to Valenza, formed the western, and the Po, from Valenza to Pavia, the southern side. The Allies were arranged almost on the arc of a circle, from Casale to Valenza and Voghera; their principal force being near Alessandria. Their length of front was, therefore, much shorter, and they had, besides, railway communication along its whole extent. The Emperor Napoleon had taken up the command on the 14th. He left Paris on the 10th May, landed in Genoa on the 12th, and proceeded to Alessandria two days afterwards.

The reconnoitering force sent out by Gyulai was composed of troops from different corps, thus:—

Vth Corps: Paumgarten's Division.	Gaal	Archduke Charles regiment (Part of this regiment was at Laveno on the Lago Maggiore.)	2	Battalions.
		Liccaner Grenzer	1	„
	Bils	Zobel regiment	3	„
	Hesse	Culoz regiment	3	„
VIIIth Corps:		Part of the brigade Boer	2	„
IXth Corps: From Urban's flying Division.		Braum's brigade, Rossbach regiment	2	„
	Schaafgottsche	Jägers	1	„
		Hesse regiment	1	„
		Don Miguel regiment	1	„
Cavalry		12th (King of Sicily) Lancers	3	Squadrons.
		12th (Haller) Hussars	3	„

Artillery, 16 guns.

As the number of men in these brigades was not mentioned in the official reports, it is difficult to decide what their strength really was. The French, naturally assuming the credit of having fought against an overwhelming number, calculated the brigades at their full strength, and estimated the whole force at 30,000 men. M. Rüstow puts it at about the same number; but the author of a small work, called "Skizze des Feldzuges, 1859, in Italien, von einem Süddeutschen Offizier," declares that there were only 16 battalions, and part of another, amounting in all to 15,000 men. After comparing the list of casualties with the various accounts, it appears likely that that number of battalions is correct; but if they were so few in number, they were most likely up to their proper strength, and the infantry, cavalry, and artillery may safely be put at 20,000 men.

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The command was entrusted to Count Stadion, of the Vth Army Corps. His orders were to advance until he met the enemy in force, and to threaten Voghera, in order that the whole of the available troops in that neighbourhood might be displayed. Gyulai expected to obtain thus certain information as to whether the Allies intended an attack in the direction of Piacenza.

Voghera and its neighbourhood were occupied by the Ist French corps, under Marshal Baraguay d'Hilliers; Forey's division being at Voghera and Oriola, with outposts towards Stradella and Pavia. The rest of the corps lay along the railway to Tortona. Ten squadrons of Piedmontese cavalry were attached to the corps until the regiments appointed to it were ready for service, and detachments of them occupied Casteggio.

The troops, then, on whom it devolved to check the advance of the Austrians, were composed of the Piedmontese cavalry and Forey's infantry. On the morning of the 20th their positions were:— See Plate, No. 4.

		Battalions.
Beuret's Brigade.	17th Chasseurs	1 at Voghera.
	74th Line	3 „
	84th „	2 at the Luxia stream, 2 miles east. 1 at Voghera.
Blanchard's Brigade.	91st „	2 at Pizzale, 1½ mile east of Oriola. 1 at Oriola, 3 miles north of Voghera.
	98th „	3 at Oriola.

Piedmontese Cavalry—	Squadrons.
Aosta regiment	4 } at Casteggio.
Novara	4 }
Montferrat	2 at Pizzale.

On the 19th May the brigades Schaafgottsche and Braum, under the command of Lieutenant Field-Marshal Urban, were near Broni and Stradella, on the post road from Voghera to Piacenza. Paumgarten's division was at Pavia, and Boer's brigade was at Vaccarizza, where, as before mentioned, a bridge over the Po had been constructed. During the night Paumgarten moved down to Vaccarizza, a distance of about four miles, and on the 20th May the several brigades advanced thus:—

Left	Urban — Schaafgottsche and Braum	on the road from Stradella to Casteggio, 9 miles distant.
Centre	Gaal, to Rebecco (3 miles from Casteggio) 10 miles march.	
	Bils, to Casatisma (3 miles from Casteggio) 10 miles march.	
Right	Hesse, to Branduzzo (4 miles from Casteggio) 11 miles march.	
Reserve	Boer, to Barbianello (6 miles from Casteggio) 5 miles march.	

From these points a further simultaneous advance was to be made at noon. Branduzzo, Casatisma, and Robecco are in a line which cuts the Stradella road, about three miles from Casteggio. It is to be supposed, therefore, that Urban, who had the best road and shortest distance to march, should have halted at that point until he received orders for the further advance, in which Gaal's brigade was to act as his support.

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Urban has been accused of attacking too soon, and there is no doubt that he occupied Casteggio about midday, when Gaal could be only just within three miles. This brigade was not brought into use till after three p.m.

See Plate, No. 4.

Arrived at Casteggio, Urban met with some slight opposition from the cavalry and inhabitants, but no serious fighting took place until he approached Genestrello. Here he met the first of the French infantry, and drove them back to the other side of the small Fossagazzo brook.

Intelligence of this reached Voghera at half-past twelve, and Forey proceeded in haste to the spot with the first few battalions that could be got ready. The Austrians, on their side, prepared for a fresh advance, and at 1.45 p.m. the troops were respectively placed thus:—

AUSTRIANS:

Braum's Brigade on the railway; two battalions.

Schaafgottsche's on the post road, with the Jägers on the hills beside it; three battalions.

Gaal at or near Robecco. *Bils* at Casatisma; *Hesse* at Branduzzo; and *Boer* at Barbianello.

FRENCH:

Beuret's Brigade — 84th: 1 battalion on the right, 1 on the left of the road, behind the brook.

Beuret's Brigade — 74th: 1 supporting the 84th, 1 on the railway at Cascina Nuova, ½ mile north.

The 3rd battalions of these two regiments and the Chasseur battalion of the division, were on their way from Voghera. Two guns were placed on the bridge over the brook. Blanchard's brigade was also sending up some of its battalions to Genestrello.

Cascina Nuova, which is a hamlet of three or four houses, was the first point attacked; but Colonel Cambriels, with his single battalion of the 74th, gallantly defended it. In the meantime, reinforcements began to arrive, and Forey, assuming the offensive, employed the first three battalions in an attack on Genestrello; the next four were sent to Cascina Nuova. Soon afterwards the Austrian brigade was driven out of Genestrello, and that at Cascina Nuova had to retire in consequence.

It was now past three o'clock. The Austrians took up a fresh position at Montebello, whilst the French made arrangements for attacking them a second time.

Blanchard's brigade was formed on the left at Cascina Nuova; Beuret's on the right, at Genestrello. The battalion of the 74th, which belonged to the latter, rejoined it from Cascina. Beuret was to storm Montebello from the high ground, whilst Blanchard, leaving one battalion to garrison the Cascina, was to threaten it from below. The cavalry and artillery remained principally on the road.

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The Austrians had barricaded the village, and made such preparations for defence as the short time would allow. Gaal's brigade, which had taken up its proper position in support, was now brought to the front, and would receive the first attack. Schaafgottsche and Braum were a little in rear. See Plate, No. 5.

Between four and five o'clock the fighting began again; it lasted nearly two hours. The houses were carried one by one; at last the churchyard only remained; this was evacuated by Stadion's order, and at half-past six the French were in full possession of the village and heights.

The Prince von Hesse, whose brigade formed the extreme right of Stadion's force, had met two battalions of the French 91st regiment near Oriolo, where, as already mentioned, they had been in position when the battle began. The Prince had a numerical superiority of at least 5 to 2, and further brought up a battalion of Bils' brigade from Casatisma, which made the proportion 3 to 1. He effected, however, nothing beyond keeping those two battalions from joining Blanchard's brigade (to which they belonged) at Cascina Nuova. The Austrian writers, taking for granted that he had to contend against superior, not inferior numbers,* spoke in glowing terms of his achievement. His services were officially recognized by the reward of a regiment and promotion to the rank of Lieutenant Field Marshal.

Stadion, forced to retire from Montebello, fell back upon Casteggio, which is on the next spur of hills, and brought Bils' and Hesse's brigades to join the other three there. A brigade of the IXth Corps (Fehlmayers) which did not belong to the expedition, had also been hurried towards the field by Lieutenant Field Marshal Crenneville, and was at Borgo St. Giulietta. The two battalions of Boer's brigade seem to have remained at Barbianello. Forey did not feel himself strong enough to attempt anything more. The day came to an end, and during the night Stadion fell back to Vaccarizza.

Both parties claimed the merit of having struggled heroically against superior numbers; with what justice, we will proceed to consider.

The numbers engaged at different periods of the day seem to have been :—

AT CASCINA NUOVA.

Austrian.		*French:*	
Rossbach regiment (Braum's Brigade), 2 battalions -	2,400	At first—	
		74th regiment, 1 battalion -	800
		Afterwards came—	
		91st, 1 battalion - -	800
		98th, 3 battalions - - -	2,400
			4,000

* Skizze des Feldzuges, p. 20.

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AT GENESTRELLO.

Austrian:		*French:*	
Jägers 1 battalion, Hesse 1 „, Don Miguel 1 „ — Schaafgottsche brigade.	3,500	At first— 84th regiment, 2 battalions; 74th „ 1 „	2,400
		Afterwards— 84th regiment, 1 „; 74th „ 1 „; 17th Chasseurs, 1 „	2,500
			5,000

AT MONTEBELLO.

Austrian:		*French:*	
Schaafgottsche, as above	3,500	Beuret's Brigade, as at Genestrello, with the 3d battalion of 74th	5,800
Archduke Charles, 2 battalions; Liccaner Grenzer 1 battalion (Gaal's Brigade)	3,500	98th regiment, 3 battalions (Blanchard)	2,400
Rossbach regiment, 2 battalions (Braum's Brigade)	2,400		8,200
	9,400		

AT ORIOLO.

Austrian:		*French:*	
Culoz regiment, 3 battalions (Hesse Brigade)	3,500	91st regiment, 2 battalions (Blanchard's Brigade)	1,600
Zobel regiment, 1 battalion (Bils' Brigade)	1,200		
	4,700		

There are no accounts of any French regiments being engaged except those above detailed. The Austrians must, therefore, have had an enormous superiority at Oriolo, and an advantage at Montebello. Even if their battalions were only 1,000 strong, they were equal to the enemy at the most important period,—the contest for the village of Montebello.

It will be observed that they brought under fire only 12 battalions, although they had 16 on the ground under Stadion's orders. The French supposed, from the number of brigades, that there must have been 28 battalions in the reconnoitring force, and took it for granted that they had contended with and defeated the whole of them. On the other hand, the Austrians, perceiving that reinforcements in great numbers were brought up by railway trains before night closed, attributed their defeat to the combined action of the whole, although only 10,000, at most, had an active share in it.

Rüstow criticizes severely the generalship of Count Stadion in not bringing more men into action on his left, and in not using his reserves in larger masses, and in a more offensive manner. Stadion certainly did not distinguish himself; but the danger of his right being turned, and his retreat cut off, obliged him to be cautious. He was also charged with the difficult task of bringing to a satisfactory conclusion what should never have been attempted at all;—never attempted, because at all times a reconnoissance like this is a measure

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of dubious utility, and here peculiar difficulties attended its execution. The fruit trees grow so closely that troops only a short distance off are concealed by them. Stadion could not, therefore, ascertain the Allies' strength until he was so close that an action was unavoidable, if *they* chose to begin one. It was only to be expected they would do so if the advantage of numbers promised success; and then he would be committed to an unequal contest with a superior enemy, ten miles away from the rest of his own army.

It seems strange that this difficulty should have been overlooked, for an Austrian column had been as far as Voghera a fortnight before; and Urban had since made frequent incursions from Pavia in that direction. It was particularly undesirable to fight the first battle under such circumstances, lest the morale of the soldiers should be impaired.

General Forey, who received the attack, acted, no doubt, very differently from what Stadion expected. He took the offensive even with inferior numbers; disregarded the chance of his left being thrown back; used every available man for advancing his right; and gained the day by this bold but hazardous attack.

The details of his losses are not given. He estimated them in his despatch at 700 killed and wounded. The *Journal des Débats*, some time afterwards, put the French and Piedmontese together at 850; other accounts have laid them at 1,500, which M. Rüstow thinks a reasonable estimate. In officers, they had 11 killed and 40 wounded.

The Austrian losses were 295 killed, 715 wounded, 283 missing; total, 1,293, of whom 41 were officers.

By the published list of casualties, it appears that the average losses in each battalion were:—

Schaafgottsche Brigade - -	170	In front at Genestrello, and again engaged at Montebello.
Gaal's Brigade - - -	150	In front at Montebello.
Braum's Brigade - - -	100	Engaged at Cascina Nuova and Montebello.
Hesse's Brigade - - -	57	At Oriolo.

The casualties at Genestrello and Montebello being nearly three times as numerous as those at Cascina Nuova and Oriolo, it is evident there was no very serious fighting at the latter. The artillery lost 2 killed, 9 wounded; the cavalry, 3 killed, 10 wounded. In superior officers, the French suffered most, having 1 general killed (Beuret) and 6 field officers *hors de combat*.

The action was principally confined to infantry; but it would be unfair to pass without mention the part taken by the Piedmontese cavalry. The squadrons made repeated charges on the Austrians as they advanced along the road from Casteggio, and did all that could be done to check their approach until the French were prepared to meet it.

Artillery could only act a secondary part in such a thickly planted country. Forey placed two guns on the bridge at Fossagazzo to support his attack on Genestrello; he afterwards

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had two on the high ground to the right, and employed others at the railway near Cascina Nuova, from which the high ground about Montebello is occasionally visible. The Austrians seem to have used only one battery. At Montebello they had two guns on a bit of open ground close to the church, others on a spur of the hill, along which runs the communication between the village and the post road. There they constructed a slight breastwork to give cover to the men, and the crest of the hill protected the horses,—an excellent position, except that the ground in front was so much hidden by trees.

It was probably at this point that Lieutenant Prokesch of the artillery distinguished himself. "He held the main road," says the *Times* correspondent, writing from Garlasco on the 25th May, "with two guns; waited until the enemy's column was within "40 yards, then fired and cleared the road; loaded again, waited, "fired again, and so on, until the dead and wounded barricaded "the road." He was decorated with the Cross of Maria Theresa.

The effect of the Austrian guns was, by their own account, "terrible," whilst all the enemy's shot came over their heads. M. Achard, a newspaper correspondent, described a French gun losing two men, two horses, and two wheels, immediately on coming into action. Another correspondent says, "nos pièces sont "démontées, canonniers et chevaux sont decimés par la mitraille." This is enough to show that the Austrians made good use of the few guns they employed; but there are no accounts or traces of much destruction being effected by the artillery on either side.

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CHAPTER III.

OFFENSIVE OPERATIONS BEGUN BY THE ALLIES.—BATTLE OF PALESTRO.

The battle of Montebello, on the 20th May, concluded the first phase of the campaign. The Austrians had crossed into Sardinia with a force twice as large as their opponents could bring to meet it; they had spent three weeks in making demonstrations; they had not taken advantage of their superiority by striking a decisive blow, and now their opportunity was gone: the 70,000 untried Sardinians were supported by 150,000 of the best soldiers in Europe. So far as regarded numbers, the scale was turned in favour of the Allies; and if they had not advantages equal to those which the Austrians had thrown away, they were at least no longer compelled to remain within their lines of defence.

The French Emperor, acting as General-in-Chief, had no sooner received sufficient cavalry, artillery, and bridge equipage to complete the organization of his army, than he began to act on the offensive. Already, on the 18th May, the Piedmontese had collected pontoons, and other necessary materials for re-establishing the communication at Valenza, which the partial destruction of the railway bridge had interrupted. The Austrians, however, opened a cannonade which destroyed several pontoons, and caused the attempt to be abandoned. See Plate, No. 15.

On the 20th Cialdini occupied Vercelli, which the Austrians had abandoned on the preceding day. On the 21st he crossed the river, forcing Gablentz' brigade of Zobel's corps to retire from Borgo Vercelli to Orfengo; but on the 22nd he was compelled to return to the right bank of the river, as Zobel had brought up several other brigades to oppose him.

The same day (22nd May) Victor Emmanuel, with Castelborgo's division, crossed the Po at Casale, and marched towards Candia, but returned the next day after some skirmishing, and the occupation of some small islands in the river. Fanti's division replaced Castelborgo's on that side of the Po, and occupied also some small islands in the river not far from Candia. On the 24th the Austrians suddenly opened fire upon them from a masked battery of eight pieces, thrown up the night before; and the Piedmontese retired out of their range to the right bank. Durando's division had, in the meantime, moved up to Pezzana and Prarolo (five miles south of Vercelli) in support of Cialdini.

The failures on the Po at Casale, and on the Sesia near Candia, showed that an attempt to cross any large river, where the Austrians were prepared to oppose the passage, would be extremely hazardous, if not futile. On their left and centre, where the Po could not be passed without a bridge, they evidently ex-

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pected an advance; the Emperor, therefore, decided on turning their right flank. This had been lately weakened of troops, and was covered only by the Sesia, which infantry and cavalry could wade through.

On the 23d May he visited Vercelli in person, and commenced on the 28th a rapid movement towards that place. His object was of course to push on to Milan, where the inhabitants would rise in his favour; and from Vercelli there is a direct and excellent road; but to march along it was rather dangerous, with the enemy in such strength on his flank. To occupy the country on its south side was, at all events, indispensable. A vigorous attack on the enemy's outposts which held it would secure the flank, and might also lead him erroneously to believe that his centre near Mortara was the point threatened. The Piedmontese being most in advance towards Vercelli, this operation was intrusted to them, with Canrobert's corps d'armée in support; and led to the two days' fighting called the battle of Palestro.

On the first day the Austrian outposts were driven back from Palestro, Vinzaglio, and Confienza; and their attempt to re-establish themselves failed.

On the second day the Austrians made another attempt to regain their lost ground, but without success.

The details are as follow:—

See Plate, No. 6.

On the 29th May Fanti's, Durando's, and Castelborgo's divisions joined Cialdini's at Vercelli. During the night the French Sappers and Sardinian Pontoniers repaired the arches of the bridge which the Austrians had blown up, and on the following morning the divisions crossed over it. It was arranged that Cialdini (4th division) should take the Robbio road, on which Palestro stands at a distance of five miles from the bridge; that Durando (3d division) should turn off the road at Torrione, and advance through Parnasco on Vinzaglio (about the same distance); and that Fanti (2d division), going round by Borgo Vercelli and Casalino, should send one of his brigades to Confienza, the other to join in the attack on Vinzaglio. This entailed a march three miles longer than the other two. Castelborgo was to follow Fanti to Confienza in reserve.

The Austrians, quite unsuspicious of an attack, had only the usual outposts to resist it. These were furnished from Robbio, three miles off, by Lilia's division of the VIIth Corps, whose chief, Zobel, had his head-quarters at Mortara, nine miles beyond Robbio. Palestro was occupied by the Grenadier battalion of the Archduke Leopold regiment with two guns, and it happened that two other companies, with a battalion of the Wimpffen regiment, were on their way to relieve it.

Cialdini, with three battalions on the right of the road, one on the left, the rest of the Regina brigade between them, and the Savona brigade in support, advanced under the fire of four guns. The result could not be long doubtful. The Austrians had some advantage of position, being on a plateau, up which the road was

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carried by a cutting, with streams covering their front and left; but they were opposed to five times their number (reserve brigade not included) and were forced back. As they were fighting at the other end of the village, the battalion and companies for the relief chanced to arrive. They occupied the last houses, took possession of the cemetery, and were not dislodged until a regiment of the Savona brigade had been brought into action. They then, at about half past four, retired to Robbio.

Durando performed his share under very similar circumstances. He arrived in Parnasco at noon, and fired four guns to notify his arrival to the 2d and 4th divisions; he also pushed out some Bersaglieri, upon whom the enemy opened a musketry fire, which showed that they still occupied Vinzaglio. About three o'clock, after a long inactivity under a pouring rain, Durando received orders to attack without waiting for the co-operation of Fanti's (2nd) division, which had indeed three miles further to march, but ought to have arrived before that time.

A stream runs just below the rising ground on which Vinzaglio stands, and the bridge over it was barricaded. Covered by the fire of eight pieces of artillery, the column advanced, took the barricade, and stormed the village. The relief, which came up here as at Palestro, arrested for a time the capture of the place, but after an hour and a half's fighting the Austrians were obliged to give way. Their best road to Robbio was through Palestro, the capture of which was unknown to them. Retreating, therefore, towards it, they came unexpectedly on the outposts of the 16th Sardinian regiment, and in the skirmish which ensued, they were obliged to abandon two guns. See Plate, No. 6.

Cut off from this line, they had to return towards Confienza, and presented such a threatening appearance that Durando arranged his troops for a fresh attack. The 2nd battalion Bersaglieri, with a squadron, had been sent round in that direction at the beginning of the engagement; these threatened the flank; the 10th Bersaglieri, part of the 8th regiment, and the Pinerolo brigade, threatened the front, and two guns opened fire along the road. The Austrians then finally retreated at about half-past six.

Durando's report makes no mention of any junction with Fanti's division; but according to the latter, one of his brigades reached Vinzaglio simultaneously with the assault of the 3d division, and took part in the repulse of the enemy. Afterwards, it returned to Confienza, where the other brigade had established itself without opposition. The only delay to account for Fanti being so late, was an encounter at Borgo Vercelli with a squadron of Austrian cavalry, whom he repulsed with a loss of eight killed, left on the ground. See Plate, No. 6.

Castelborgo's division reached the vicinity of Confienza at night-fall according to orders, and Victor Emmanuel slept at Torrione. Canrobert had brought his corps during the day to Prarolo near the Sesia, opposite Palestro, and as soon as he knew of the Sardinian success, began the construction of a bridge over the river. The operation was covered on the left bank by the 3rd Zouaves, who had See Plate, No. 6.

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been sent round by Vercelli for the purpose. This regiment belonged to the Vth, Prince Napoleon's Corps, but had been attached to Canrobert, and was directed to act under Victor Emmanuel's orders on the following day. The Sardinians strengthened themselves in the villages they occupied; but it was intended that they should proceed to attack Robbio in the morning, whilst the French crossed over in their support.

This plan was forestalled by the Austrians attacking instead. Zobel had determined to retake the position. The *Edinburgh Review* (article in the September number 1859) says he was ordered by Gyulai to do so; but the latter seems to have been still at Garlasco, ten miles off, and it is more probable that Zobel took what steps he thought advisable without applying for instructions, which indeed could hardly have been carried out so soon as the following early morning. As the other division of his own corps was fully occupied in watching the lower Sesia towards Candia, and could not be withdrawn without risk, he applied to Prince Liechtenstein, of the II^{d} Corps, for troops to reinforce Lilia. Liechtenstein put at his disposal Jellachich's division (Brigades Szabo and Kudelka) then quartered at Cergnago, twelve miles off, and the leading troops of it arrived at Robbio at 8 A.M. on the 31st. Zobel had come to confer with Lilia at 2 o'clock in the morning, and arranged the plan of attack. Weigl was to march on Confienza (4 miles); Dondorf on Palestro (2½ miles to the outposts); Szabo on the south side of Palestro, by Rivoltella (4 miles); Kudelka was to hold himself in reserve on the post-road.

See Plate, No. 7.

The leading brigades were put in motion at half-past 8, and opened fire together about 10. Weigl, who had only 4 battalions, or 4000 men, was received by the whole of Fanti's division, which, at a similar calculation, would be 10,000 strong in infantry alone. The Piedmont brigade was in Weigl's front, the Aosta on his left flank; both moved forward to meet attack with attack. Against such a superior force, backed by a similar superiority in artillery, success was hopeless, and Weigl was fortunate to effect his retreat on Robbio as easily as he did.

At Palestro, Cialdini had placed the Regina brigade in front (9th and 10th regiments); the Savona brigade in rear (15th and 16th regiments); the 9th covered the Rivoltella road at Cascina St. Pietro; the 10th was in advance of the village towards Robbio; the 15th supported the 10th, the 16th was on the road to Confienza. Of the two Bersaglieri battalions, the 6th was on the left of the 10th regiment; the 7th, which had suffered a good deal the previous day, was in reserve at Palestro.

Dondorf and Szabo together had about 9,000 men, and meeting at first little more than one brigade of Piedmontese, were able to push on nearly to the village.

Cialdini, supposing that their principal object was to occupy the ground on his right and destroy the French bridge, sent the 16th regiment and 7th battalion Bersaglieri to that flank, and requested the assistance of the 3rd Zouaves. The 7th Jäger

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battalion, which led Szabo's brigade, had crossed a canal, which is only passable at a narrow bridge called the "Ponte di Brida," and were at some distance from it. Four guns had followed them over, and the other four of the battery had been brought into action on the banks of the Sesia close by. Their left was covered by a stream called the Sesietta; this the Zouaves unexpectedly forded; the depth of water spoiled their ammunition, and the fire from the guns put 250 *hors de combat;* but they climbed the bank, rushed up to the battery, and fell with the bayonet on the Jägers' flank and rear. A flanking fire from twelve French guns on the opposite side of the Sesia arrested in its march the Archduke William regiment, which ought to have supported the Jäger; and the latter, partly by wounds, partly by prisoners, and partly by being drowned in the canal, lost 500 men. The suddenness of the attack, with the difficulties arising from the narrowness of the bridge, and the stickiness of the soil from a heavy rain, caused also the loss of the guns. Five were taken by the Zouaves, the other three by the 16th regiment and 7th Bersaglieri, who arrived from the left flank in time to support the charge.

Kudelka's brigade was ordered to renew, from the main road, the attack on Palestro, in which Dondorf had been unsuccessful; but its advance was checked by a stream so deep and wide as to be impassable. Nothing, therefore, was effected by any one of the brigades. Between two and three o'clock they gave up the contest and retired to Robbio, having suffered severely, and lost eight guns.

The Austrian casualties, by their official report, amounted to—

Killed - - -		15 Officers.	513 Men.
Wounded -	1 General.	23 „	878 „
Missing - - -		6 „	774 „
	1	44	2,165

About $\frac{1}{7}$th of the number engaged, not including Kudelka's brigade.

Those of the Piedmontese were not published; they were probably about the same, and are said to have been more or less in different accounts, according as the writer sympathizes with the German or Italian cause. The charge and pursuit by the Zouaves cost them 46 killed, 229 wounded, and 20 missing; the latter accounted for as having in their ardour "rolled in the canal" whilst "precipitating" the Austrians into it.

On both days the Austrian soldiers were uselessly committed by their generals to an engagement with superior numbers. Palestro and Vinzaglio were not in a state to resist such an attack as was made on the 30th; the retreat out of houses is most difficult when the enemy has approached; and the more tenaciously such positions are defended, the greater is the inevitable loss of life. We may suppose that the officers in command of the posts felt themselves bound to resist in the absence of particular orders; but considering that the advance from Vercelli was begun early, that the attack was made at a late hour, that Durando (and probably Cialdini) halted for three hours in sight of the places, and that Lilia was at

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only three miles distance, there must have been time for communications to be received. Lilia had only 8,000 men under his orders, and could get no more reinforcements that day; either then he acted in ignorance of the enemy's strength, or he committed a great mistake in not retiring without unnecessary bloodshed.

The Sardinians so fully developed their force during the afternoon, that Lilia certainly ought to have known that two whole divisions had been engaged, besides that which the squadron at Borgo Vercelli had come in contact with, so that, putting Castelborgo's division and Canrobert's corps out of the question, he had at least 27,000 infantry to defeat before he could regain the lost ground. Against these 27,000, Zobel and Lilia sent, on the 31st, four line regiments and two Jäger battalions, numbering perhaps 18,000 men, of which number one half was weakened and dispirited by the defeat of the previous day, and the other half had to march 15 miles to the scene of action. These being the circumstances under which the battle began, what other result but their defeat could naturally follow?

In these two actions, cavalry was of even less use than at Montebello; artillery about the same as before. At Palestro, on the 30th, the Austrians had two guns on the high ground close to the main road, in a most favourable position for raking it; but as the Sardinians could turn the flank under cover of the trees, they were not necessarily exposed to the fire. They, in their attack, opened fire from four guns at about 1,500 yards range on the road, "with good effect" (official report); but later in the day two of their guns coming into action just outside Palestro, on the road to Robbio, were dismounted (rovesciato) by the Austrian artillery.

Against Vinzaglio the Sardinian artillery fired "without much effect." After the enemy had evacuated the village, guns were brought up to the outlets from it, on the other side, and put an end to the action by forcing him to withdraw from the roads which their fire commanded.

The capture of the Austrian guns on the following day was a rather remarkable incident; but it is difficult to make out under what circumstances it really happened, and how far the result was really complete. The French account is, that the Zouaves, finding themselves exposed to the fire of the guns, marched up to their front and took them at the point of the bayonet. The Austrians, on the contrary, maintain that the true cause of the guns being lost was the difficulty of moving them, which equally prevented the Sardinians from carrying them off after they were abandoned.

This account is adopted by the *Edinburgh Review;* and certainly the *Times* correspondent, writing from Mortara on the 1st June, says, "Five of the seven guns left sticking yesterday have been recovered by a division of the second corps, skirmishing near Palestro to day." On the other hand, Victor Emmanuel, who had accompanied the Zouaves in their charge, and distinguished himself by his gallantry in the affair, says, in a letter to the colonel on the following day, "I fully appreciate your Zouaves' idea of bringing

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to my head-quarters the pieces of artillery taken yesterday from the Austrians. I shall make a point of sending this fine trophy to His Majesty the Emperor." One would infer, though it does not quite follow, from the wording of this letter, that *all* the guns were brought away. A newspaper letter describes *one* being drawn to Palestro by twelve prisoners. The opposite statements seem quite irreconcileable; and it is nowhere stated that the Austrians lost or abandoned more than eight pieces, so that the difficulty cannot even be avoided by concluding that two separate batteries are in question.

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CHAPTER IV.

From the Beginning of the Flank March to the Battle of Magenta.

See Plate, No. 3.

The position occupied by the Allies on the 28th May, when the flank march began, was the same as that described before the battle of Montebello (p. 218), only the arc on which the two armies were arranged, now extended to Vercelli, as the Piedmontese had crossed the Po at Casale. The Austrians were still in the triangle facing the Sesia and Po; and except that Gyulai strengthened his centre after the battle of Palestro, they remained stationary until the 2nd June.

The execution of the flank march is shown by the following daily movements:—

28th May.—IIIrd Corps (Canrobert) from Ponte Curone (near Voghera) to Casale.

29th May.—Piedmontese concentrate at Vercelli; IIIrd Corps moves to Prarolo; IInd, IVth, and Imperial Guard Corps commence the march to Casale.

30th May.—Piedmontese occupy Palestro, Vinzaglio, and Confienza.
IIIrd Corps constructs a bridge at Prarolo.
IVth „ (Niel) from Casale to Borgo Vercelli.
Imperial Guard from Casale to Vercelli, part by Trino, 9 miles west of Casale.
IInd Corps (M'Mahon) on the march to Casale.
Ist „ remaining at Voghera.

31st May.—Piedmontese engaged at Palestro and Confienza.
IIIrd Corps crosses the Sesia to Palestro.
IVth „ at Borgo Vercelli.
Imperial Guard, one division at Vercelli, one on the march.
IInd Corps reaches Vercelli.
Ist „ remaining at Voghera.

See Plate, No. 3

1st June.—Imperial Guard crosses the Sesia.
IInd and IVth Corps pushed on to Novara and Olengo.
Ist Corps moved from Voghera to Vercelli.

2d June.—Piedmontese take up a position along the Agogna.
IIIrd Corps on Piedmontese right, near Robbio.
Imperial Guard enters Novara, and sends one division on to Turbigo.

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3d June.—Ist Corps—from Vercelli to Novara.
IInd „ one division at San Martino, the other at Turbigo.
IIIrd Corps brought up near Novara.
IVth „ at Olengo and Novara.
Imperial Guard, one division at Turbigo, one at Trecate, to which it had advanced from Novara.

No opposition was made in the course of this flank march except at Novara, where a small number of infantry, with a squadron of lancers and some guns, inflicted what loss they could without offering a serious resistance.

"They made good their retreat to San Martino," says the *Times* correspondent, writing from Mortara, "with a loss of 7 *killed and* 15 *wounded*, having put *ten* times their number *hors de combat*." The French correspondents give, however, a very different account. According to them, four guns were abandoned at the bridge over the Agogna without firing a shot; two others at the entrance of the town were fired once and left; at the cemetery on the east side, two more guns and 300 prisoners fell into their hands, whilst the loss suffered by themselves was only two *killed* and a few wounded. Such are the different versions which must (in more important events) be compared and weighed before a reliable account can be produced.

It will be observed that the Ist Corps, which formed the extreme right of the allied army, was not moved till the last, to prevent if possible the alteration being noticed. On the day that Canrobert left Ponte Curone for Casale, the Imperial Guard marched from Alessandria to Voghera to replace it, and apparently there were but few admitted to the secret of the movement intended. Skilfully, however, as it was carried out, a more enterprising enemy might have frustrated it. The IInd, IIId, and VIIth Austrian Corps might have been brought up, and taken Niel and M'Mahon at a great disadvantage on the 1st June; but Gyulai was still intent upon his centre he moved his head-quarters to Mortara, brought the IInd Corps there from St. Giorgio, the IIIrd to Trumello, and ordered them all to be ready to move at a moment's notice.

On the night of the 31st May Zobel's outposts heard the railway engines at work between Casale and Vercelli. On the following morning they observed masses of French troops on the march from Vercelli towards Novara; and Zobel, in reporting the circumstance, requested permission to att ak them with the three corps abovementioned. It was, however, then too late; the nearest division would have had to march 15, the furthest 24 miles; they would have been exposed to the Piedmontese and Canrobert's corps on their flank, and would have found the French, perhaps, in equal numbers after all. Gyulai made no move that day; but on the 2d June the real intention of the Allies could no longer be mistaken; he then sent orders for all corps on the right of the Ticino to move to the left bank, and for the two corps at Pavia and Piacenza to march northwards. Ciam Gallas' corps, just brought by

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railway into Italy, had already reached Magenta, and was watching the Ticino opposite Novara.

Louis Napoleon had attained his object. Between him and Milan on the 2d June was only a river of no great size, guarded by one incomplete corps; it only remained to cross this, if possible, before the other Austrian corps came up. Whilst then a column threatened the bridge on the main road, the Voltigeur division of the Guard, accompanied by a pontoon train, proceeded to construct another at Turbigo, six miles higher up the stream.

See Plate, No. 8.

As there was no enemy to oppose the operation, it was finished by the morning of the 3d. M'Mahon's corps was then put in motion, Espinasse proceeding to San Martino, and La Motte Rouge to Turbigo.

The latter, accompanied by M'Mahon, began to cross at half-past 12, just at which time Cordon's Austrian division, detached by Clam Gallas, a day too late, to watch this point, entered Robecchetto on its way to Turbigo. As this village might be made a serious obstacle to any further advance, M'Mahon at once resolved to drive the enemy from it. He placed the Algerian Tirailleurs in front; one battalion directed against the south side of the village, one against the west, and the third in reserve between them. The 45th Line was to follow, and the other brigade (65th and 70th regiments), arranged in similar order on the left, was to watch against the flank being turned.

At two o'clock the Algerians advanced, covered by the fire of a field battery; without firing a shot they entered the village, and a quarter of an hour's fighting put them in possession of it. The 65th regiment, moving round to the north side of the village, was threatened by a body of cavalry from Castano; but showing itself to be supported by artillery and prepared for an attack, the cavalry withdrew.

Cordon retired under fire of his guns, took up a fresh position between Robecchetto and Malvaglio, and sent out a battalion along the canal, which encountered the Voltigeurs of the Guard. Finding that there was a superiority of numbers at this point, and that in artillery also he had the disadvantage, Cordon again withdrew to Cuggiono, whilst La Motte Rouge's division occupied Robecchetto with the Voltigeurs of the Guard in a second line behind it.

The French lost only 8 killed and about 40 wounded. This is a very trifling loss considering that the division was 8,000 strong, and shows that the Austrians were not bent on holding their position. The strength of the latter was probably about the same; their loss not given; one of their guns, however, was abandoned in the high corn.

Whilst this was taking place at Turbigo, it had been ascertained at San Martino that the bridge on the main road had not been destroyed, but was passable for infantry, and, with some repairs, for artillery. The first attempt to blow it up had failed, and, as the Austrians abandoned, at the *tête de pont*, two guns, two howitzers and some ammunition waggons, it may easily be conceived

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that their departure was too hurried to remedy the failure. The responsible engineer accounted for the fault by a too simultaneous ignition of the charge, which was fired by electricity. It appears from a photograph* that two arches were displaced, but each of them had sunk on one side only, close to the pier, without leaving a chasm across the road.

Whatever the cause, the result was most important, for Louis Napoleon had now two undisputed communications with the left bank of the river instead of one, which just doubled his chance of reaching the Austrians on that side before their forces were concentrated. That they would give up Lombardy without a battle was not to be expected; and the issue of it must be doubtful; but skill and good fortune had put the Allies in a more favourable position for trying the event than had appeared likely some weeks before.

To return to the Austrian movements. On the night of the 2nd June, the IInd, IIIrd, and VIIth Corps left the neighbourhood of Mortara and crossed the Ticino by the Milan road near Vigevano; the Vth Corps from San Nazaro, and the VIIIth from the country west of Pavia crossed it at Bereguardo; the IXth remained between Pavia and Piacenza. See Plate, No. 8.

The IInd Corps marched on to Robecco and Ponte di Magenta; the IIIrd and VIIth to Abbiate Grasso, with one division of the latter in advance at Corbetta (a mile east of Magenta); the Vth Corps took the direction of Abbiate Grasso, and the VIIIth of Milan.

At daybreak on the 3rd June, Count Hess, sent to Gyulai by the Emperor, met him at Bereguardo, and had a long private interview. The *Edinburgh Review* says it was not decided *till then* that the progress of the French should be stopped at Magenta; but the directions in which the several corps were already marching seem to indicate the contrary; and Gyulai's defenders maintain that the interference of Hess spoiled a well-arranged plan, and caused the loss of the battle. Certain it is, that the IIIrd, Vth, and VIIth Corps were all stopped on their march by orders issued after this interview; but how far this caused the loss of the battle the reader may judge by the further accounts.

The San Martino bridge was supposed to be blown up, and no report of the failure had reached head-quarters; but it was known that the French had effected a passage at Turbigo, and the attack was therefore expected on that side. The first three brigades of the IInd, and two of the VIIth Corps bivouaced on the night of the 3rd in a line facing that way from Boffalora to Corbetta; six other brigades were five miles to the rear, in the neighbourhood of Abbiate Grasso. The line facing the Ticino was not, however, unprotected, but works had been thrown up which must have required some time, and been executed either by Clam Gallas' corps, or when the *tête de pont* was constructed.

* Topographical Department (Copy).

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Between the river Ticino and Magenta there is first a flat plain for a mile and a half; then a steep irregular bank, some sixty feet high, with a flat table-land on the top; the former is intersected by numerous irrigating channels, and belts of trees and bushes; the latter is cultivated for vines and corn, with young fruit trees planted even closer than on the battle-fields already described. The railway and post-road run very straight across the plain, and are liable to be swept by artillery fire from the high ground, all along which, at the edge of the bank, there are favourable positions for guns.

See Plate, No. 11.

The railway, which crosses the river at the same point as the road, diverges a little to the south, but alters its direction at the bank, and crosses the road about a mile from Magenta, which it leaves on its south side. A few hundred yards from the bank runs the "Naviglio Grande," or Great Canal, which is the most important feature of the ground.

Issuing from the Ticino at Oleggio, it communicates with Pavia, passing Turbigo, Boffalora, Abbiate Grasso, and Bereguardo. Its stream runs nearly four miles an hour, and in the neighbourhood of Magenta it has steep banks on each side covered with bushes of the robiglia plant, (a sort of acacia with very long, hard thorns). Altogether, it forms an obstacle quite impassable, except at the bridges; if these were properly barricaded, and protected by artillery, an attacking army, coming unexpectedly upon it, must certainly be arrested in its advance, and most likely thrown back in confusion. If Louis Napoleon was aware of the difficulties attending its passage, he was rash to make the dispositions which he did; but it could not be reconnoitred, and no map expresses its full importance as a feature of military defence.

Where the railway enters the bank by a cutting, a quantity of earth had been quarried out to form the embankment over the plain; here the Austrians had a sort of redoubt. Further back, at a second bank, they had another entrenchment, and all the bridges were mined. At the critical moment, however, only two out of four were exploded. A French account says that, at the railway bridge, the man who was about to fire the charge was bayonetted, and the assailants pressed on so close that it could not be done; but a more probable account is, that the engineers calculated on getting powder from Milan, which was not forthcoming.

The *Austrian* troops actually on the ground, on the morning of the 4th June, were—

Ist Corps.—Cordon's and Montenuovo's Divisions	4	brigades.
IInd Corps.—Jellachich's Division and half Herdy's	3	„
At Robecco, 3 miles from Ponte Nuovo di Magenta, which may be considered the centre of the field—		
IInd Corps.—The other half of Herdy's Division	1	„
At Corbetta, 3½ miles from the centre—		
VIIth Corps.—Reischach's Division	2	„

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These ten brigades, at their proper strength, would be 60,000 men; but the Austrians will only allow each brigade to have been 3,500 to 4,000 strong, and in that case the force would be about 37,000.

Further off, but available during the day, there were—

At Castelletto, a little east of Abbiate Grasso, Lilia's Division, VIIth Corps, 2 brigades.
Near Abbiate Grasso (6 miles from the centre) 3 brigades (Ramming, Hartung, Durfeld), IIIrd Corps.
Between Abbiate Grasso and the Ticino, on the road to Cassalo Nuovo, the other brigade (Wetzlar's), IIIrd Corps.

These six brigades, 22,000 men, might be brought into action four hours after the order was transmitted.

Two other complete corps were rather too distant for service on the 4th, but might be calculated on for the day after, viz.:—

VIIIth Corps, at Binasco, 17 miles off; Vth Corps, at Fallavecchio, 12 miles off: amounting to at least 30,000 men.

The IXth Corps was at 25 or 30 miles' distance.

Mensdorf's cavalry was at Abbiate Grasso, and took some share in the day's fighting. Urban's flying division of three brigades, recalled from the north of Lombardy, where it had been watching Garibaldi, was at Gallerate, only 10 miles from Cuggiono, and, as the mass of French troops was expected on that side, it seems an error that he was not made use of to check their advance, by threatening an attack as they crossed the river.

The whole *allied* army was within 15 miles of the scene of action. The Ist, IIIrd, and IVth Corps at or near Novara; one division (Grenadiers) of the Imperial Guard at Trecate; the other division of the Guard, with one of M'Mahon's corps, between Turbigo and Robecchetto; and the other division of the IInd Corps on the right bank of the Ticino. The Piedmontese were all at Galliate, so that, after making a similar deduction from the strength of their battalions as from the Austrian brigades, the allied forces amounted to— For these places, see Plate No. 8.

At Novara, 12 miles off, 119 battalions	70,000	men.
At Trecate, 6 miles off, 11 battalions	6,500	„
At Turbigo and right bank, 7 miles off, 38 battalions	23,000	„
At Galliate, 72 Piedmontese battalions	34,000	„
	133,500	men.

Thus they had 133,000 within the same distance as the Austrian 89,000 (Vth and VIIIth Corps included); but, having to cross a river passable at only two points, they were under a great

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disadvantage as to the facility of bringing their forces into action. This might have proved fatal to their success.

The San Martino bridge was not yet practicable for artillery. Before anything else, it was necessary that the roadway should be made good; then the plan was, that M'Mahon should advance from Turbigo, supported by the Piedmontese, and that his attack on the north side should be the signal of another from the west by the Grenadier division of the Guard and Canrobert's corps.

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CHAPTER V.

Battle of Magenta.

Wimpffen's brigade of the Grenadier division, Imperial Guard, left Trecate at eight in the morning; at half-past nine it crossed the bridge, and, leaving Sappers to strengthen the roadway, made some advance into the plain. There the Austrians opened fire upon it with rifles and artillery, to which Wimpffen replied; but General D'Angely, commander of the corps, who came on the ground with the rest of the division at half-past eleven, ordered the useless skirmishing to cease, and withdrew the brigade to the bridge. The Emperor appeared about the same time, and waited for M'Mahon's signal to begin the attack.

Clam Gallas, who had reported to Gyulai some hours before that he was threatened by masses of French troops on this side, now sent pressing demands for reinforcements. Gyulai, in his despatch, stated that at the first communication he ordered the corps at a distance to advance with all speed; if so, they ought to have been now close at hand, but the first of the brigades did not come up from Abbiate Grasso till half-past five in the evening.

At half-past one M'Mahon's expected cannonade was heard on the north side of Magenta, and the Emperor ordered the Imperial Guard to advance. Under the command of General D'Angely they proceeded to the attack in three columns:— See Plate. No. 9.

The 3d Grenadiers (3 battalions), partly by the railway, partly by the fields, to Ponte Vecchio di Magenta.

The 1st Grenadiers (3 battalions), supported by the Zouaves (2 battalions), to the railway-bridge and Ponte Nuovo di Magenta.

The 2d Grenadiers (3 battalions), to Boffalora, by the country road.

The attack on Ponte Vecchio was the first to succeed; by dint of hard fighting, the Grenadiers drove back the Austrians to the east side of the canal. They blew up the bridge behind them, and the Grenadiers, not being able to pursue the advantage, kept two battalions to occupy the houses, and sent the other to assist the 1st regiment and Zouaves at Ponte Nuovo. There, also, the Austrians were driven over the railway-bridge. Either from want of powder, or want of time, it was not blown up after them. The French crossed over also, moved on Ponte Nuovo by the east bank of the canal, and thus attacking it on two sides, carried it after a hard contest.

At Boffalora also they were successful—more so than at Ponte Vecchio; for, although one arch of the bridge was destroyed, the

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French made a narrow way across it by help of some planks which were lying near. This is said to have been done under a heavy fire of musketry and artillery from the opposite side, and was a very gallant thing to be done in the face of any resistance whatever.

But before this bridge was taken, whilst, on the contrary, the Guards seemed to recede from the canal and heights rather than establish themselves thereon, the cannonade on M'Mahon's side ceased, and Canrobert was not even in sight of San Martino. This state of affairs filled the French Emperor with anxiety. The Grenadier division, unsupported by either the IInd or IIIrd Corps, was in imminent danger of being crushed by superior numbers. It is related that he even sent orders to bring up artillery for covering the retreat, whilst Gyulai was writing to the Emperor at Verona to announce that the attack upon him had failed.

Canrobert had been delayed by the encumbered state of the road. In a distance of only ten miles he was about three hours later than calculated upon.

M'Mahon had been checked by the Austrians under Cordon. The time fixed for his leaving Turbigo was ten o'clock; the two divisions already there had seven miles to march; their co-operation might be expected at about midday; the other division on the right bank was to come up on the left flank at Marcallo, and could not be expected till later. The leading division of Piedmontese, commanded by Fanti, moved down to the bridge at nine; the French were to cross first; but Fanti, finding they did not appear, marched over. At the other side he again waited till nearly noon to allow them to pass him, but hearing then that M'Mahon had left Turbigo, he likewise started for Castano and Buscate. Urban's outposts being within three miles, he had to proceed with caution.

Cordon's division had passed the night at Magenta; its furthest outposts were at Casale, a mile south of Cuggiono, and the leading French battalions came in sight of them at 1 P.M. After a skirmish, in which, probably, those guns were fired which Louis Napoleon heard at the Ticino, the Austrians withdrew from that point, but M'Mahon soon found himself in face of formidable numbers, drawn up between Boffalora and Cascina Guzzafame. No longer able to continue the march, he deployed the division (La Motte Rouge's) of his own corps in line with the Cascinas Valisia and Malastalla, keeping the Voltigeurs of the Guard in a second line. He sent to order Espinasse to continue this deployment towards Marcallo as quick as he could, and requested support from the Piedmontese division then at Castano, five miles away.

See Plate, No. 9.

With these dispositions he made an attack, which was simultaneous with that of the 2d Grenadiers on the Boffalora bridge. The African Tirailleurs and 45th regiment, directed on the village, had the important effect of causing the Austrian artillery (two batteries of guns and one of rockets), taken in rear, to leave their position; and Clam Gallas, giving up Boffalora, brought Montenuovo's division nearer Cordon's in the direction of Cascina

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Nuova. This farmhouse likewise M'Mahon stormed; and, after a sanguinary contest, took; but Clam Gallas still preserved a threatening attitude. La Motte Rouge's division required re-forming after an hour and a half's fighting, and Espinasse was separated by some considerable interval. M'Mahon, therefore, proceeded to take up a line between Cascina Nuova and Cascina Guzzafame, with the Guard in rear, as before. Clam Gallas made no attack, and that cessation of firing ensued which caused such anxiety to the French Emperor.

Gyulai slept at Abbiate Grasso (five miles off) on the 3rd. When Clam Gallas reported the indications of a battle, he desired him to hold the position, and did not quit head-quarters till the middle of the day. Then he went to Magenta, and, being informed of the state of affairs, he ordered up Reischach's division, VIIth Corps, from Corbetta, to re-take Ponte Nuovo, and secure Clam Gallas' front and rear. Directly afterwards he rode off to Robecco, away from the scene of action, in order to show the IIIrd Corps, when it arrived, what road it was to take. The Kintzl brigade of Herdy's division, IInd Corps, was sent at once against the Ponte Vecchio by the west side of the canal. Hartung's and Durfeld's brigades of the IIIrd Corps were to follow it, and Ramming's to take the same direction on the other bank. Wetzlar's brigade was to operate against the French flank in the middle of the plain.

Kintzl reached Ponte Vecchio at half-past four. He found the bridge blown up, the Hartmann regiment on the opposite side, and two battalions of Grenadiers occupying the houses on the west. These he attacked; but Piccard's brigade of Canrobert's corps came up, a battalion of the 1st Grenadiers also came to assist them from Ponte Nuovo, and Kintzl, quite outnumbered, fell back after an hour's fighting before he could receive the support of the IIIrd Corps. When the brigades Hartung and Durfeld did arrive, they obtained a partial success, and held their ground until further reinforcements from Jannin's brigade of Canrobert's corps, and from Vinoy's division of Niel's corps, joined their opponents. Then they retired to Robecco; and, at the same time, Ramming's brigade on the east side, also fighting against an increasing enemy, retired likewise. See Plate, No. 10.

Reischach's division had come into action before Kintzl's brigade. At Magenta it was divided; one half was sent to Boffalora, the other attacked the Imperial Guard in front of Ponte Nuovo with such impetuosity as to drive them back to the bridge with the loss of one gun. General Cassaignolles, with a squadron or so of cavalry, endeavoured in vain to check the cloud of skirmishers which covered the advance, and the infantry had barely time to occupy the houses on the east side. These, however, they held from four to five o'clock, when Vinoy's division of Niel's corps made its welcome appearance. With its help the Guard again took the offensive, and soon the French were strong enough to drive Reischach back from point to point, as well as to send several battalions towards Ponte Vecchio on both sides of the canal. The See Plate, No. 10.

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effect of those battalions in repulsing the IIIrd Corps has been mentioned.

About the time that the IIIrd Austrian Corps retired from Ponte Vecchio, and whilst Reischach was slowly giving ground towards Magenta, M'Mahon renewed the attack, employing now both divisions of his corps. La Motte Rouge was directed from Cascina Nuova straight towards the church tower of Magenta; Espinasse advanced from Marcallo, and the Guard was between them. Clam Gallas and Liechtenstein still struggled doubtfully in front of the village, when Auger, commanding the artillery of the IInd Corps, brought up battery after battery by the Boffalora road to the railway, until he had 40 pieces ranged along it. Their fire hastened the final retreat of the Austrians. The Piedmontese also came up on the left of Espinasse at a little before seven, and the 9th battalion Bersaglieri, with four pieces of artillery, took a part in the last assault of the day.

See Plate, No. 10.

Lilia's division of the VIIth Corps, although quite as near as the brigades of the IIIrd Corps, did nothing but cover the retreat on Corbetta. Wetzlar's brigade of the IIIrd Corps never got near the French flank in the plain, owing to the difficulties of the road. Of the more distant corps, the Prince of Hesse's brigade of the Vth made a gallant but ineffectual attempt to retrieve the day on the west side of Magenta, and a brigade of the VIIIth took some part in the conflict.

See Plate, No. 10.

The French brought on the field in the course of the day two complete corps (Imperial Guard and M'Mahon), two divisions of the IIIrd, and two divisions of the IVth corps. There is some reason to suppose that part of the Ist Corps was engaged, although not mentioned in the despatches. The IVth (Niel's) Corps was to have remained at Trecate; and Vinoy's division had arrived there, when an aide-de-camp from the Emperor ordered it to proceed. Probably all the available troops were brought up as fast as they could be moved.

On the night of the 4th June, these troops rested on the ground they had won. The foremost Austrians were in a line of four miles extent from Casterno to Corbetta; the ruins of the Ist and IInd Corps (Clam Gallas and Liechtenstein) were at Bareggio, three miles from Corbetta towards Milan.

On the 5th, Gyulai, still at Abbiate Grasso, proposed to renew the action, and sent Hartung's brigade to retake Ponte Vecchio. This was done without much difficulty; but in the meantime he heard from Bareggio that the Ist and IInd Corps had gone to Milan, and required entire reorganization; this information changed his plans, and he ordered a general retreat. The VIIIth Corps, Benedek's, was sent to Malegnano on the Lambro, ten miles south-east of Milan, the others in a more southerly direction towards St. Angelo and Pavia, east of which, at Belgiojoso, he established his head-quarters.

For these places, see Plate, No. 8.

The Austrian position at Magenta was not of deliberate choice and regular occupation, like the heights of the Alma, or banks of

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the Chernaya (French) in the Crimean war; but it was partially entrenched, had been entered upon by part of the army three days previous, and was so far advantageous, that with equal numbers the defenders ought to have held their own with ease.

The result was just the contrary; before reinforcements joined either side, during 2½ hours' fighting, the respective numbers were,—

At the four bridges on the canal: Austrians, four brigades, 15,000 men; French, Grenadiers, and Zouaves of the Guard, 11 battalions, 6,600 men. (General d'Angely says they were less than 5,000 strong.)

On the north side: Austrians, three brigades, 11,000 men; French, 25 battalions of the Guard and IInd Corps, 15,000 men.

If with such a superiority of numbers and an excellent position, the Austrians could not hold their ground along the canal, it was only a natural consequence that they should be defeated at other points where their advantages were less. Magenta was a repetition of Montebello on a larger scale; it brought out more strongly the difference between the two nations, and showed that generalship alone was not to blame for the result of the day.

When Reischach came up to Ponte Nuovo, he brought about 3,700 fresh men, who had only performed a three miles march, against half-a-dozen battalions of the Guard, wearied by hard fighting, weakened by losses, and numbering less than 3,500 men. No wonder then that he drove them back to the bridge—wonder rather that he did not accomplish more. Vinoy's division turned the scale again, and the French pushed on to Magenta.

Similarly, the Kintzl brigade did but little against two battalions of the Guard; 3,700 against 1,200, and the arrival of Piccard's brigade settled the issue. Again, on the same ground, two other Austrian brigades acted the same part with the same result.

At the north side, their most favourable moment was when Montenuovo, replaced at Boffalora by one of Reischach's brigades, had been united to Cordon; then Clam had all his own force together, and equal or nearly so to M'Mahon in number, he should have attacked with energy before Espinasse had brought the other division into its place.

The six French divisions mentioned as engaged, contained 101 battalions, and may be put at 60,000 men; in 15 of them there were no casualties, so that 9,000 men had little to do with the victory. The Austrians employed the Ist, IInd, IIIrd, (except Wetzlar's brigade), and VIIth Corps; one brigade of the Vth and one brigade of the VIIIth Corps. These 17 brigades must have contained 64,000 men. Mensdorf's cavalry were on the ground and partly engaged, but cavalry could have no influence on a great battle in such a peculiar country.

The more one analyses the circumstances, the more inconsequent does the result appear. The apologists for the German army

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attribute much of its failure to fatigue, forced marches, hunger, and weight of the accoutrements under a burning sun. The *Times* correspondent, writing from Vienna, said that two-thirds of the men had been without solid food for 36 and even 48 hours. These excuses may be well founded, but the two last reflect on the organization of the army, and the two first would be an evidence of inferiority on the part of the soldiers, as they might be equally pleaded on the other side. On the morning of the 4th seven Austrian brigades were on the very ground; three within four miles; five brigades at the same distance as M'Mahon, and the Imperial Guard, who were the *nearest* French troops; and the other two had about as far to march as the four divisions of Canrobert's and Niel's corps.

With regard to previous days' marches, Clam Gallas' corps had been brought by the railway on the 1st and 2d June, the others had marched from Mortara, 20 miles, on the 2d and 3d. The French army had been on the move for six days, and traversed 75 miles of ground, the first 40 in trains, the last 35 on foot.

That some regiments were disinclined to fight, there is no doubt. One battalion, 2d Jägers of Montenuovo's division, surrendered in a body at Cascina Nuova; that farmhouse might have been made the Hougoumont of Magenta. Two regiments disgracefully fled; a lieutenant, trying to make a man face the enemy, was bayonetted by him in the arm; in return, he shot the fellow with his pistol.

The great omission in defensive preparations was, that the bridges over the canal were not sufficiently attended to. It would have been better to make them impassable at once and give up the heights beyond the canal altogether, than to run any risk of the French forcing a passage. A couple of thousand men and six guns would have been enough to watch each bridge, and 30,000 men might have crushed M'Mahon as he approached. 20,000 more, being the very force near Abbiate Grasso, would have been available for a flank attack on the French by an advance on the west side of the canal from Rebecco, if the events of the day rendered it advisable.

M'Mahon, if defeated, was lost; his only retreat was over a bridge crowded with troops and baggage, and Urban's corps at Gallarate might have completed his destruction. Louis Napoleon was powerless to assist him, without first gaining the Boffalora bridge.

All this hinged on the canal which looks on the map such a trifling impediment. The fact of the French not forcing a passage at Ponte Vecchio, till it was turned from Ponte Nuovo, shows what might have been done elsewhere if the bridges had been properly destroyed. At Boffalora the effect of blowing up the bridge was neutralized by some planks being carelessly left close by, which restored the roadway as soon as destroyed.

The delay in making use of the brigades at Corbetta and Abbiate Grasso is inexcusable. The brigades sent along the western side of the canal would have been better employed on the eastern. By

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the former they met an enemy continually receiving fresh reinforcements, and could not co-operate with the brigades on the other bank; the only excuse, and a lame one, must be, that the Austrian retreat to the east side, and the blowing up of the bridge, were not known to the commander-in-chief.

The commander-in-chief had, as already described, gone to the scene of action about two o'clock, stayed there perhaps half-an-hour, and then ridden three miles away to give instructions which an orderly might have conveyed. He did not return. His quickness in leaving Magenta is in contrast to his slowness in the morning, for though he heard from Clam Gallas between eight and nine o'clock that the French motions indicated a battle, it is clear that he did nothing till after noon.

Whatever interference may have impeded Gyulai, and spoilt his arrangements before, his conduct on this important day showed that he was unfit for the command, and he was no longer continued in it.

It might be supposed that the Austrians, in excusing themselves for their defeat, would impute it partly to the new French guns; but neither the newspaper reports of the time, or the personal accounts since, acknowledge any superiority except in length of range. Up to this time the new artillery had not obtained a fair trial, and the notices of it, by writers with the Austrian army, were invariably disparaging.

The 40 guns concentrated by General Auger (if, indeed, 40 there were, for our guide, an inhabitant of the place who saw the action, entirely denied it, and we could not find any likely position for such a number,) included the reserve guns of the IInd Corps, as well as those attached to the four brigades; or perhaps the number was made up from the Voltigeur division of the Guard. The French are said to have used rockets with success; and at Ponte Vecchio, if not elsewhere, they brought up guns by hand. This was probably an application of their new system of attaching guns to infantry regiments.

The nature of the ground afforded very favourable situations for the Austrian artillery; but the French do not seem to have suffered from it in their first advance over the plain, so much as would be supposed. In number of batteries, perhaps, the Austrians were deficient. Clam Gallas is said to have had only 18 guns; he ought to have had 88; but as the reserve artillery of each corps had hardly time to come up, the total number on the field (at one battery to each brigade) would be 136. They lost four; one taken by the Grenadiers of the Guard, the other three by M'Mahon's corps.

The French lost one of two guns which were sent forward to cover the retreat on Ponte di Magenta, when Reischach advanced upon it. The Austrians pressed on so close, and were so much concealed by the vineyards, that the artillery was in fact surprised. One gun was captured, the other only saved by being carried off (*emmenée à bras*) by the men.

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The official returns on the Austrian side gave—

Killed -	63 Officers.	1,302 Men.	1,365 Total.
Wounded -	218 „	4,130 „	4,348 „
	281	5,432	5,713 „
	About $\frac{1}{12}$th of the force engaged.		
Missing -	0	4,000	0

The battle put, therefore, nearly 10,000 men *hors de combat* in the Austrian army.

The first account of the French loss published in the *Moniteur* gave 2,488 killed and wounded, 208 missing; but a detailed list, published afterwards, amounts to—

Killed -	52 Officers.	512 Men.	564 Total.
Wounded -	194 „	2,951 „	3,145 „
Missing -	0 „	735 „	735 „
	246	4,198	4,444
	About $\frac{1}{14}$th of the number engaged.		

The 11 battalions of Grenadiers and Zouaves of the Guards lost—

Killed -	8 Officers.	117 Men.	125 Total.
Wounded -	29 „	632 „	661 „
Missing -	0 „	157 „	157 „
	37	906	943—$\frac{1}{7}$th.

The 13 battalions of Voltigeurs and Chasseurs suffered in a very trifling degree, viz. :—

Killed -	0 Officers.	13 Men.	13 Total.
Wounded -	3 „	51 „	54 „
Missing -	0 „	45 „	45 „
	3	109	112—$\frac{1}{70}$th.

The 3rd Grenadiers and Zouaves lost more than 130 in each battalion; the 2nd Grenadiers, 53, and the 1st, 40.

La Motte Rouge's division, which bore the brunt of the battle on the North side, lost—

Killed -	17 Officers.	127 Men.	144 Total.
Wounded -	48 „	673 „	721 „
Missing -	0 „	217 „	217 „
	65	1,017	1,082—$\frac{1}{7}$th.

As it had one more battalion than the Grenadier division, the proportion is almost just the same.

Espinasse's division was of equal strength with the Voltigeurs, its loss six times as great, viz.—

Killed -	7 Officers.	81 Men.	88 Total.
Wounded -	24 „	401 „	425 „
Missing -	0 „	145 „	145 „
	31	627	658—$\frac{1}{12}$th.

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Of the IIIrd Corps, Renault's division, which met the Austrian counter attack on Ponte Nuovo and Ponte Vecchio, had—

Killed - -	8 Officers.	81 Men.	89 Total.
Wounded - -	36 „	691 „	727 „
Missing - -	0 „	83 „	83 „
	44	855	899—$\frac{1}{9}$th of strength.

Trochu's division arrived very late in the evening; its casualties were—

Killed - - -	2 Officers.	27 Men.	29 Total.
Wounded - -	10 „	121 „	131 „
Missing -	0 „	6 „	6 „
	12	154	166—$\frac{1}{47}$th.

In Vinoy's division of Niel's (IVth) Corps, two regiments suffered severely: 100 casualties in each battalion; the rest were untouched.

The French artillery had only 7 men killed, 15 wounded, and 6 missing: 28 in all. The Austrian artillery suffered about double that loss: 2 officers and 7 men killed, 40 men wounded, and 1 officer missing; total 50.

The loss was not very great on either side, and much less in the French army, than the long continuance of the battle, and the peculiar circumstances of the attack on the canal, would have rendered likely. The 15,000 English in the regiments, which stormed the heights of the Alma, lost 2,000 killed and wounded in three hours. At Inkerman the proportion was $\frac{2}{7}$th (2,392 in 8,000), just double that of La Motte Rouge, or the Grenadier division; and the casualties in the English batteries at that action amounted to 96.

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CHAPTER VI.

Battle of Malegnano, and Garibaldi's Movements in the North of Lombardy.

The French Emperor returned after the battle of Magenta to the right bank of the Ticino. At Robecco the Austrians believed until night that the day generally had gone well, and that with fresh troops on the morrow success would be certain. If Gyulai could have re-occupied the canal bank and destroyed the bridges, he might have fought on the second day with advantage; but to judge from what his men had already done, or rather failed to do, there was not the least prospect of such a design succeeding.

M'Mahon, too, was now supported by the Piedmontese; all the French were at Trecate. Their joint number was more than Gyulai could command, and it was decidedly better that he retreated in good order, than it would have been to risk a decisive and overwhelming defeat. The Imperial Guard and IInd Corps being quite as much disorganized as the Austrians, no attempt was made by the French to molest the retreat, and it was not till the 6th June that their leading divisions pushed on towards Milan.

Clam Gallas and Liechtenstein's corps came to Milan early on the morning of the 5th; they passed through almost without stopping; and soon after came an order from Gyulai to the garrison to evacuate the castle. Agreeably to this, the guns, 41 in number, were spiked, and the troops were conveyed by railroad to Verona next day.

On the 6th June, Louis Napoleon moved his head-quarters to Magenta; on the 7th, M'Mahon's corps reached Milan; and on the 8th the Emperor, accompanied by the King of Sardinia, made his entry into the capital.

That same day, Baraguay d'Hilliers, of the Ist Corps, in conjunction with M'Mahon, had an engagement with the Austrian rear-guard at Malegnano. Louis Napoleon ordered the attack. When Baraguay d'Hilliers received his instructions on the 7th, his corps was at St. Pietro l'Olmo, half-way between Magenta and Milan. M'Mahon was at San Donato, between Milan and Malegnano. The enemy was supposed to occupy San Giuliano, three miles further on the same road. Baraguay d'Hilliers went to consult M'Mahon at his quarters. It was arranged between them that the latter should clear San Giuliano before the Ist Corps came up; that he should then cross the Lambro to Mediglia, and proceed along that side of the river to take the Austrians in flank after they were forced into retreat from the front.

See Plate, No. 8.

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M'Mahon, approaching San Giuliano on the afternoon of the 8th June, found it evacuated, and crossed quietly over the Lambro. Baraguay d'Hilliers had 14 miles to march; the road was encumbered by the baggage of the IInd and IVth Corps, and his leading division (Bazaine's) did not arrive till half-past three, the next an hour later. At half-past four he left San Giuliano, and arrived in front of Malegnano at half-past five. It was occupied by Roden's brigade of the VIIIth Corps, which had left Landriano for Lodi on the previous day. The streets were barricaded, the cemetery prepared for defence, and a battery placed at the first houses.

To silence the artillery the French commander drew up 6 guns, as many as there was space for, in his front, and placed 12 more on his right. Three battalions of Zouaves covered the latter, and the two other regiments which formed the leading brigade (Gose's) were in column upon the main road. These troops belonged to Bazaine's division. Forey's was to act on the right, and L'Admirault's division on the left, so as to secure a complete success.

Gose's brigade, led by a battalion of Zouaves, moved forward after some artillery firing; it suffered a heavy loss from the battery and the riflemen in the cemetery, but the Austrians were forced to retire, leaving a gun behind them, and the fighting was transferred to the streets of the town.

On the left bank of the Lambro was another Austrian brigade belonging to the same division of the VIIIth Corps; this was now sent to assist Roden; but while it was advancing to do so, L'Admirault's division appeared in flank close to the river, and M'Mahon was threatening to cut off the retreat on Lodi. Instead of entering the town, Boer's brigade posted itself in a chateau outside, to cover Roden's retreat, which was become a matter of instant necessity. The chateau, an old brick building, with a dry ditch and tower over the gateway, was held until the wounded had been removed; then it was evacuated by another gate. At nine o'clock a heavy storm put a stop to the fighting, and the two Austrian brigades joined their corps without pursuit.

Baraguay d'Hilliers' despatch says that 1,200 wounded Austrians were brought to the ambulances, and 800 or 900 prisoners made. Rüstow gives the casualties as 1,200, of which 250 were killed. They, however, only acknowledged to—

Killed -	1 General.	7 Officers.	112 Men.	120 Total.
Wounded -	0	15 „	234 „	249 „
Missing -	0	0 „	142 „	142 „
	1	22	488	511

The peculiarly small proportion of wounded to killed, it being only 2 to 1, instead of 5 to 1, throws a strong doubt on the

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accuracy of the whole list. The general killed was Boer, who died of his wounds on the way to Lodi. The French lost—

Killed -	12 Officers.	141 Men.	153 Total.
Wounded -	56 „	669 „	725 „
Missing -	0 „	64 „	64 „
	68	874	942

Two-thirds of the above loss was confined to the 1st Zouaves alone, who had one-third of their strength put *hors de combat;* viz., 6 officers, 106 men killed; 26 officers, 426 men wounded; 48 men missing; total, 612.

Some hundreds of Austrians are said to have been taken prisoners during the night by being sent to reconnoitre the place, and passing the sentries without being aware of it. The Frenchman on guard slipped quietly away to the colonel of his regiment, acquainted him with the circumstance, and the party was entirely cut off and obliged to surrender.

The "German View of the War," published in the *United Service Magazine,* considers that this action was fought by the French to convey the idea of a hot pursuit,—an idea certainly not worth such a sacrifice of life. The Emperor could not have expected any hostile movement from a mere rear-guard; it did not interfere with his order of march, and a slight victory, gained in such a manner as this, was not required to increase the prestige, or raise the confidence, of his army.

For these places, see Plate, No. 8.

In the next four days the French advanced only to the Adda, 18 miles east of Milan. The Austrians continued their retreat towards the Mincio, giving up as they retired, Pavia on the 7th, Piacenza on the 10th, and Pizzighettone on the 11th. That Pavia should be evacuated was not surprising; but Piacenza was a place of some importance, and its fortifications had been strengthened with considerable labour and expense in the previous four months. It had a citadel, an enceinte, and 15 detached outworks. It was rising into a fortress of the first class, and troops issuing from it might have proved a serious annoyance to the Allies if they were driven back into Piedmont.

Either the Austrians required the garrison to reinforce the army on the Mincio, or thought there was more chance of having to withdraw it under worse circumstances, than of deriving any advantage from it. The step showed little confidence in their prospects. The citadel and part of the works were blown up, but not much damage was done by the explosion. Such of the stores as could be removed in the short time were sent down the Po on board ship, and the garrison marched to Pizzighettone.

Whilst both the armies are moving towards the Mincio, it will be as well to trace the course which Garibaldi had been pursuing in the last month.

The corps under his command was about 4,000 strong, and contained the following regiments of irregular troops, all lately raised: Cosenza regiment, Medici regiment, and Ardoino regiment,

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of two battalions each, 200 Bersaglieri, and about the same number of mounted men.

Detached from the allied army, as soon as the French came up to the frontier, Garibaldi marched towards the mountainous country on the north of the great Lombardy plain; passing through Verrua on the Po, and Biella, he brought his whole force on the 22d May to Borgomanero on the Agogna; thence he sent a detachment to Pallanza on the west side of the Lago Maggiore, and took the main body to Arona, 11 miles south of it. On the 23d he crossed the Ticino at Sesto Calende, where it issues from the lake, and on the 24th entered Varese. Being now in Austrian territory, he proclaimed Victor Emmanuel king. The inhabitants rose in his favour, and recruits filled the ranks of a fresh levy called the "Alpine Rifles" or "Chasseurs."

The news of this diversion reached Milan and Garlasco (Gyulai's head-quarters) on the 22d. The Governor of Milan sent a detachment of the garrison to Gallerate (25 miles off), and Gyulai despatched a force to Sesto Calende by way of Oleggio. On the 25th the advanced guard of this force met, at Sesto Calende, Garibaldi's rear-guard, which, after a skirmish, rejoined him at Varese.

Garibaldi prepared himself there to receive an attack; it was made the following morning. 3,000 men, two squadrons of cavalry, and eight guns tried to carry the place, but were repulsed with a loss of 132 killed and wounded. They retired to Como, whither he followed them on the next day. They again retired, and he, on entering the place, was received with the same acclamations as at Varese.

Gyulai supposed that Garibaldi was making a feint for the purpose of drawing the Austrian forces away from the left and centre. To frustrate this, he watched those points more carefully, sent out Urban's flying division to "chastise" Garibaldi, and issued a threatening proclamation to overawe the inhabitants of Como and that district.

Urban came to Monza, within 20 miles of Como, on the 27th May, and assembled 10,000 men under his command. On the 29th his leading troops had a skirmish with the Alpine Rifles, who were defeated, and spread considerable alarm in Como. Garibaldi thought it advisable to begin a retreat; he proceeded by a circuitous route near the Lake of Lugano to Laveno on the Lago Maggiore, where the Austrians had a small garrison of the Archduke Charles regiment, and some steamers. By possessing himself of this harbour, he would have a means of retreat over the lake to Pallanza, which stands opposite.

On the 31st May he made two attacks without success, and found himself, consequently, in a very dangerous situation. Urban was at Varese; Arona and Sesto Calende were in Austrian hands; he could not risk an action, and had no good means of retreat. Fortunately for him, the French entry into Novara, and the Austrian

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movements consequent upon it, caused Urban's forces to be recalled, and Garibaldi re-established himself at Varese.

Official notices of Garibaldi's movements gave it to be understood that he was acting in concert with the allied armies. If so, it must have been presumed that Gyulai would be influenced by them in exactly the way he was, for in no other manner could so small a body, 50 miles away from the extreme flank, be of any assistance. But there are stories told of the feelings entertained towards him by the French, and even some Piedmontese generals, which suggest that his presence was useless, if not dangerous, and that his services could only be acceptable, or his troops employed to advantage, by being detached in this manner. The latter were jealous of his holding a commission in the Piedmontese army, and the former remembered how he fought against the French at Rome. Employed in this way, if his expedition proved successful, the allied generals could turn it to their own profit, and if he were unfortunate, it was of little importance. The great and evident risk of his being cut off and annihilated, certainly favours such a view. It is also to be remarked that he was in the right rear of the Austrians on the 22d May, whereas the flank march was not probably decided on till the 23d; certainly not begun till the 28th; suggesting a doubt whether Garibaldi's easy advance did not point to this manœuvre as the best way of meeting the difficulties which the Allies had to contend against.

For these places, see Plate, No. 8.

Urban, recalled from Varese, went southwards to Gallarate, where his 10,000 men stood idle on the 4th June, whilst the army was being defeated at Magenta. In the general retreat which ensued, he took the most direct road for Peschiera; and his rear-guard had a skirmish at Vaprio on the Adda with the Piedmontese, on the same day that Berger's division of the VIIIth Corps was attacked at Malegnano. The garrison at Laveno went up the lake with the Austrian steamers to Magadino in the Swiss territory; there they gave up their arms, and remained till the war was over.

Garibaldi's progress was again unopposed. Still keeping considerably in advance of the Allies, and gathering fresh volunteers as he advanced, he directed his march eastwards. His view now was to occupy the communications with the Southern Tyrol. Como and Bereguardo lay in his way. From the latter he visited Milan on the 10th June, to have an interview with the two sovereigns, and on the 13th he entered Brescia, two days after the Austrians had quitted it. The advanced guard of the Piedmontese came up with him here, and on the 14th he moved on to the Chiese to make a bridge at Ponte S. Marco, where the road to Peschiera crosses it.

For these places, see Plate, No. 12.

In course of this he again came in contact with Urban, who, on his right flank, and partly in rear, was marching from Capriano to Montechiaro. Aware of their proximity, he left a detachment at Rezzate to guard against a surprise. Its outposts met Urban's flanking parties between Rezzate and Castenedolo, and drove them back to the latter place. There Rupprecht's entire brigade received them, and, taking the offensive, sent out a force which threatened

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to separate the whole party at Rezzate from the main body. Garibaldi had to relinquish making a bridge for that night, and hasten back to save his detachment. He rejoined it with difficulty, and further action was imminent, when the whole 4th Piedmontese division, sent by Victor Emmanuel from Brescia, came up to S. Eufemia (2½ miles west of Rezzate). Urban then found the numbers against him too great to prosecute his advantage; he stopped the fighting, and continued his march to Montechiaro.

No other collision took place between the 8th June and the grand battle of Solferino. In that Garibalbi had no share. He went northward from Lonato to the Tyrolese frontier, and the same Piedmontese division followed him in support.

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CHAPTER VII.

Battle of Solferino.

It is not worth while to follow closely the daily movements of the armies as they approached the Mincio. The want of bridges, which the Austrians blew up as they passed, caused the Allies a delay at each river, and the Adda was swollen by heavy rains to an extent, which presented great difficulties in throwing a fresh bridge across.

See Plate, No. 13.

Keeping sufficiently close to be always ready for an employment of their whole force, the Allies came to the Oglio on the 13th June, and the Mella on the 14th. They did not make a further general advance till the 22nd; that day brought them to the Chiese, and the next to the foot of the hilly tract south of the Lake of Garda, which the enemy's continued retreat left open to them. Contrary to expectation, the Austrians had passed the plains of Medole, where for year after year they had had a camp of instruction, without offering battle, and an unopposed advance to the first fortresses of the Quadrilateral was in prospect.

Under these circumstances the Allies began their usual march on the 24th June, and, before the day was over, had fought and won the greatest battle since 1815.

Considerable changes had taken place in the Austrian camp. On the 17th June Gyulai had an audience of the Emperor, and laid down his command. Count Schlick, a veteran of 70 years of age, who had served between 1809 and 1814, and again in 1848, succeeded him as head of the second army; but the command in chief was assumed on the 18th by the Emperor Francis Joseph himself, with Hess at his side as military adviser.

To the seven corps which had hitherto composed the combatant force was added another, the XIth, commanded by Lieutenant Field Marshal Veigl, and the whole was divided into two equal wings or armies, headed by Counts Schlick and Wimpffen. This was carrying out in the field the home organization which divides the military force of the empire into armies of four corps each. The first and second of these armies had furnished the troops for the Italian campaign. Gyulai happened to be stationed at Verona in command of the second when the war began, and was not superseded by a general being appointed for that particular service. Wimpffen was also in command of the first army at that time; but his head-quarters were at Vienna, and as the army was not sent into Italy as a complete body, he had no share in the campaign till now.

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The corps lately employed on the Ticino were now on the left bank of the Mincio; the distant garrisons in Ferrara, Bologna, and Ancona had been brought in to the north side of the Po, and up to the 23rd June everything indicated an intention of trusting to the support of the Quadrilateral for the next engagement. Then Francis Joseph suddenly led back his soldiers towards the Chiese, with the view of coming upon the Allies before they had completed the passage of the river; and of forcing a battle upon them when their divisions were least prepared to receive such an attack.

The right wing was to occupy the ground between Lonato and Castiglione, which are five miles apart; the left wing was to take up a perpendicular line of equal extent, stretching from Castiglione to the Chiese. All the corps being east of the Mincio, at distances between 16 and 20 miles from their intended positions, it was decided to allow two days for the advance. See Plate, No. 12.

A reconnoissance on the 22nd reported the French main body still beyond the Chiese, and on the 23rd the march began, the greater part of it being allotted for the first day's work. The order of march, and the troops which took part in it, were as follows:—

Right Wing.—Second Army, commanded by COUNT SCHLICK.—Head Quarters, Volta.

VIIIth Corps: Benedek.	Lang	Lippert	5 Battalions	From near Peschiera to Pozzolengo, crossing the Mincio at Salionze.
		Tauber	5 „	
		Philippovitch	5 „	
	Berger	Wattervliet	5 „	
		Rovey	5 „	
	Hussars		4 Squadrons	
Vth Corps: Stadion.	Sternberg	Koller	5 Battalions	From Salionze to Solferino, by Valeggio, outposts as far as Le Fontane.
		Festetics	5 „	
	Palffy	Gaal	5 „	
		Bils	5 „	
		Puchner	5 „	
	Lancers		4 Squadrons	
Ist Corps:	Stankovics	Hoditz	5 Battalions	From Quaderni to Cavriana, by Valeggio.
		Rezniczek	5 „	
	Montenuovo	Pastori	5 „	
		Brunner	5 „	
	Lancers		2 Squadrons	
VIIth Corps: Zobel.	Prince of Hesse	Wussin	4 Battalions	From St. Zenone to Foresto, by a temporary bridge at Ferri.
		Gablentz	5 „	
	Brandenstein	Fleischacker	4 „	
		Wallon	5 „	
	Hussars		4 Squadrons	
Reserve Cavalry.	Mensdorf	Zichy	14 Squadrons	From Rosegaferro to Tezze, by Ferri.
		Holstein	12 „	

To the VIIIth Corps was attached a brigade (with 4 battalions) of the VIth Corps, then watching the Tyrolese frontier. It was brought down from Roveredo on the Adige to Peschiera (37 miles), and joined the VIIIth Corps at Ponti on the 23rd; Reichlin-Meldegg commanded it.

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Left Wing.—First Army, commanded by COUNT WIMPFFEN.—Head Quarters, at Cereta, near Volta.

IIIrd Corps: Schwarzenberg.	Schönberger	Pokorny	5 Battalions	From Pozzolo to Guidizzolo, by Ferri.
		Dienstl	5 „	
	Martini	Wetzlar	5 „	
		Hartung	5 „	
	Hussars		8 Squadrons	
IXth Corps: Schaafgottsche.	Mandl	Castiglione	5 Battalions	From Goito to Ceresole. 2 Battalions sent forward to Medole.
		Augustin	5 „	
	Crenneville	Blumenkron	5 „	
		Fehlmayer	5 „	
	Lancers		4 Squadrons	
XIth Corps: Veigl.	Blomberg	Dobrzenski	5 Battalions	From Roverbella to Castel Grimaldo.
		Host	5 „	
		Baltin	5 „	
	Schwarzel	Sebollendorf	5 „	
		Greschke	4 „	
	Lancers		4 Squadrons	
IId Corps: Liechtenstein.	Jellachich	Szabo	5 Battalions	From Mantua to Marcaria on the Oglio.
		Wachter	5 „	
	Hussars		4 Squadrons	
	The other Division remained at Mantua.			
Reserve Cavalry.	Zedwitz	Vopaterny	16 Squadrons	From Mozzecane to Gazzoldo, to join Liechtenstein next day.
		Lauingen	12 „	From Mozzecane to Medole, by Goito.

Right Wing,	92 Battalions,	40 Squadrons.
Left Wing,	74 „	48 „
	166	88

The Emperor Francis Joseph and his staff slept at Valeggio, and the march was to be resumed at nine o'clock in the morning. An action might take place in the evening, but was not for a moment thought of early in the day; in any case, the right wing was to engage first, and the left wing coming up at the proper time would ensure the victory.

The Austrians had pushed forward no reconnoissance on the 23rd, beyond the ordinary outposts; neither had Louis Napoleon; but he had made use of an expedient seldom resorted to, though not entirely new—observation from a balloon. The first ascent was made at Castenedolo on the 21st, another on the 23rd. The distance was too great to learn much, for the Austrians were 10 or 12 miles even from Montechiaro, and it requires a powerful glass, combined with favourable circumstances, to distinguish infantry from cavalry at 5 miles; but the observers might, and probably did, perceive long lines of approaching dust. This would be enough to indicate that some important movement was taking place. It is admitted that Louis Napoleon was aware of strong columns having crossed the Mincio, but he expected nothing more than a strong reconnoissance.

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On the evening of the 23rd his forces bivouaced in a line from Desenzano on the Lake of Garda to Mezzano on the Oglio; the appointed routes for the various corps on the 24th were as follows:

Four Piedmontese divisions, from Desenzano and Lonato to Pozzolengo by Rivoltella and Madonna della Scoperta.

Ist Corps (Baraguay d'Hilliers) from Esenta to Solferino; one division by the direct mountain road through Astore, the other two by Castiglione.

IInd Corps (M'Mahon) from Castiglione to Cavriana, by the Guidizzolo road for the first four miles.

IVth Corps (Niel) from Carpenedolo to Guidizzolo by Medole. The cavalry regiments attached to the different corps were formed into two divisions under Generals Partouneaux and Des Vaux, and accompanied this corps.

IIIrd Corps (Canrobert) from Mezzano on the left bank, to cross the Chiese by a pontoon bridge near Visano, and proceed to Medole by Castel Goffredo.

Imperial Guard (d'Angely) was in rear of the rest at Montechiaro, and to march to Castiglione.

The cavalry of the guard and artillery, 36 squadrons and 8 batteries, were still further back at Castenedolo, 14 miles from the plain of Medole.

At Piadena on the Oglio, 15 miles south of the battle field, was Autemarre's division of Prince Napoleon's corps, intended to join the rest of the army at the Mincio. Its presence there, unexpected by the Austrians, embarrassed Liechtenstein at Marcaria, and had thus some effect on the battle.

The appointed lines of march for the two armies on the 24th actually crossed one another, so that a collision was inevitable, and the outposts were already so close that it must necessarily begin at an early hour. The French had 168 battalions and 96 squadrons, which, at a similar calculation of strength to that at Magenta, and with artillery included, would be 120,000 men. The four Piedmontese divisions would be 40,000, and the whole would amount to 160,000 men. The Austrian battalions engaged numbered 156 (those of the IInd Corps not included), and there were 68 squadrons accompanying them; these, reduced like the others from the normal strength, would, with artillery, be 140,000; but as many of them had neither endured long marches or been under fire, this is certainly too low an estimate for the whole, and they were quite equal, if not superior, in number to the Allies.

In guns, the Austrians had, or ought to have had by their organization, a great numerical superiority; neither general had selected his ground or prepared for the combined employment of the various corps. Perhaps appearances were most in favour of the Austrians; but any one who could have studied the battles of Montebello and Magenta, would have had most confidence in the French.

It is worth while for a tourist in this part of the country to stop at Desenzano for the sake of the beautiful scenery which the hills

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and lake afford. An excursion to Solferino (8 miles) will bring him to the highest point of ground on the south, and the name "Spia d'Italia," given to the old feudal tower above the village, does not exceed the reality, for a more extensive view there could hardly be. The surrounding district is well fitted for such a battle as took place in it,—a battle between 300,000 men, commanded by two emperors and a king. The ground is broken by vineyards, enclosures, and irregularities, which afford excellent cover for riflemen, but it is open enough for the deployment of troops in masses, and has excellent roads for removing them from point to point. Favourable positions for guns can be found on the undulations of the hills, and there is generally an ample range for their fire. The plain of Medole below is adapted for the most brilliant cavalry and horse artillery manœuvres, whilst the whole could be watched and directed from the high ground.

The leading French troops started at two o'clock A.M. to avoid the heat of the day. At early dawn, the first shots of an outpost, a mile and a half from Castiglione, opened the battle; others were soon heard extending right and left, until a line from San Martino to Castel Goffredo, eleven miles long, would indicate very nearly that of the first encounters. At the first sound of a cannonade, Louis Napoleon hastened from Montechiaro towards Castiglione. He received, on the way, reports which convinced him that no reconnoissance, but a great battle was to be dealt with, and he shaped his measures accordingly.

The allied columns were moving along seven different roads; and as the whole of the Imperial Guard, infantry, cavalry, and artillery was in rear, there were only 130,000 men to a front which was then of twelve miles extent. The first step, therefore, was to send orders for the right and left to close as much as they could to the centre, and for the Guard to hasten its movements; the next was to study the enemy's line of battle, to discover his weak points, and to direct his own forces upon them. The village of Solferino appeared to be the place whose capture would give the best results, and arrangements for its attack would be in accordance with the orders already issued; it was therefore decided upon.

This resolution was adopted, and the intention communicated to the corps' commanders very early in the day; but it was some time before any result could ensue. On the extreme left, at San Martino, the 3rd and 5th Piedmontese divisions were overmatched; the next, at Madonna della Scoperta, was also thrown back. So far from assisting the centre, these three divisions drew the other away from it for their own support. Fortunately, the Austrians also were weak in numbers on this side, and could not pursue the advantages they gained.

Baraguay d'Hilliers' corps was directed on Solferino by the original order of march, and may be considered the centre which the others were to approach. M'Mahon, who stood next, had large forces opposite himself, and could not lessen the space between the centre and the IInd Corps, without, at the same time, opening an

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equally dangerous interval between the IInd and IVth Corps; he could only deploy across the Guidizzolo road, which he was moving along, and maintain himself for the present in that position. Niel was anxious to assist; but he, in his turn, was dependent on Canrobert, who had been instructed by the Emperor to support him, but at the same time to guard against a large body of Austrians approaching him from the direction of Mantua. See Plate, No. 13.

The cavalry of the line which accompanied Niel was, however, put by the Emperor at M'Mahon's disposal, and filled a vacant space on his right.

Niel took Medole from the few infantry and cavalry which held it about seven o'clock, and advanced towards Casa Nova and Rebecco; he hoped, with Canrobert's assistance, to capture Guidizzolo, and seriously impede, if not cut off, the enemy's retreat by the main road to Goito. Such an attempt required, however, the whole strength of his corps, and he could not leave Rebecco until Canrobert was ready to occupy it. He did not get the latter's assistance until too late to accomplish his object; but at eleven o'clock one of his divisions was near enough to the IInd Corps for M'Mahon to begin a movement to the left. See Plate, No. 13.

The division of La Motte Rouge proceeded to join the nearest troops of the centre attack; De Caen's gradually followed it. At half-past two the Cavalry of the Guard came to strengthen the connection with Niel, and the whole corps altering its direction then to the right, attacked and took San Cassiano. Part of it also took, but lost again, a field-work on the hills between that place and Cavriana. The interval towards Niel was again threatened; the Ist Corps on the other side was not equally advanced along the hills, and M'Mahon paused for a time in his forward movement.

Baraguay d'Hilliers' corps, advancing along and on each side of the high range which runs from Castiglione towards Solferino, had, with assistance of the Imperial Guard, taken that place about half-past one o'clock. The manœuvre of the day was so far successful; a prominent central point was captured, and a considerable mass of troops was available for pursuing the advantage. Cavriana was the next point threatened. The hills leading to it were carried one after another, and at five o'clock the French were in possession of it. Just then a violent storm passed over the field, and put an end to the struggle which had now lasted twelve hours. At nightfall the Allies were in a line nearly parallel to the first encounters, and from one to four miles in advance of it. See Plate, No. 13.

The Austrian army was left without a head till eleven o'clock. The staff started at six, but the Emperor and Hess were not to leave Valeggio till half-past seven. When the former had got beyond Cavriana, an orderly met them with a report, dated six A.M., that an attack had begun on the whole line. An hour passes away, and still the Emperor does not appear; then a message comes that he is at Volta,—the staff go there,—miss him,—gallop back, and at last find him at Cavriana.

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There was but little generalship displayed after his arrival. Brigades came up to assist at points which were hard pressed, but were not combined or employed for any distinct object. After the centre became disorganized by the French success at Solferino, some attempt was made to neutralize the result by an attack of the left wing on Niel's corps, which was still in a precarious situation. The Generals proposed to launch against him the IIIrd, IXth, and XIth Corps, but his energetic action had already forced them to use nearly their whole strength in purely defensive fighting, and there were but few fresh troops to employ in the counter attack. However, they made, between three and four o'clock, a feeble attempt to retake Casa Nova and Rebecco. At the same time, Niel, having received support from Canrobert to the extent of one division, was about to assault Guidizzolo; he was repulsed, but nothing more, and was on the point of assaulting again with further help from the IIIrd Corps, when the storm, already described, burst over the plain.

Benedek only of the Austrian commanders had beaten off the troops opposed to him, and might have done more; but his isolated success was not sufficient to retrieve the general defeat, or to alter the decision for a retreat of the whole army.

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CHAPTER VIII.

Details of the Battle.

Having given a general sketch of the battle of Solferino, it remains to describe more closely the events and arrangements in different parts of the field. Looking at them from the side of the Allies, they may conveniently be treated in three parts, according to the objects in view, and the co-operation of the various troops; viz. :—

1st. Operations between Solferino and the Lake of Garda, confined to the Piedmontese, at San Martino and Madonna della Scoperta. See Plate, No. 13.

2d. Operations in the centre, directed against Solferino and Cavriana, by the Ist Corps, IInd Corps, and Imperial Guard.

3d. Operations in the plain against Guidizzolo, by the IVth and IIIrd Corps.

Piedmontese Operations.

The Piedmontese, like the French corps, started between two and three in the morning. Being already within ten miles of Peschiera, it was considered probable that a six miles march might bring them to the Austrian outposts, so that they were preceded by three reconnoitering columns,—one between the Lake of Garda and the railway, one along the road to Pozzolengo, and the other from Lonato to Madonna della Scoperta.

The latter, composed of two battalions, a squadron, and two guns, found Madonna della Scoperta and its neighbourhood occupied by advanced posts, principally from the VIIIth, and partly from the Vth Corps. It attacked them, and was not only repulsed, but driven back some distance. The whole of the 1st division gradually took part in the engagement. At two o'clock the place was still in the Austrian hands; but the withdrawal of part of the troops, consequent on the loss of Solferino, left for its defence only the detachments of the VIIIth Corps, who gave it up soon afterwards. At four o'clock one brigade (Piedmont) of the 2d division came upon the ground, but had little share in the conflict.

The reconnoitering column on the Strada Lugana (from Pozzolengo to near Rivoltella) met the Austrians at Ponticello, a mile short of Pozzolengo, at half-past seven. After the first skirmishes, the fighting resolved itself into a contest for the possession of some elevated ground, situated a mile and a half further back; called, from a small church there, the heights of San Martino. The

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Austrian battalions, driving back the reconnoitering column, took up a position on it, and the Piedmontese, bringing up one brigade after another, made a fresh assault with each as it arrived.

Benedek had about 20,000 of his men at this point. The Piedmontese employed during the day five brigades,—a more than equal number of men in the gross. At their most important attack they had, however, only three, of which one was already in disorder; the Austrians, on the other hand, were all concentrated, so that the Piedmontese soldiers fought under a disadvantage.

The Cuneo brigade, 3d division, was the first to arrive in support of the reconnoitering columns; it attacked at once (nine A.M.), and carried the lower spurs of the hills, but failed in reaching the higher points. Once thrown back, it was pursued towards the railway, and was only saved by coming under the protective fire of the 5th division artillery, which, sent forward at a trot, preceded the infantry advancing from Rivoltella. This was about ten A.M.

The Casale brigade of the 5th division was in advance, and attacked immediately; the Acqui brigade did the same as it came up. They forced back the Austrians to the highest points of ground, and kept up the attack for two hours, but had no reserve to occupy what they had won. The Pinerolo brigade, 3d division, did indeed arrive at one o'clock, and was just moving up to take its part, when the leading battalions of the Casale and Acqui brigades, exposed to the fire of 30 pieces of artillery at 250 yards, gave way. The next followed; the Pinerolo brigade was not prepared to retrieve the disorder, and the whole 5th division retreated from the field.

See Plate, No. 13.

Between St. Zeno and Rivoltella the 5th division stopped to reform its shattered battalions; the Pinerolo and Cuneo brigades took up a position along the railway to secure the communications with Desenzano and Rivoltella, and a pause of two or three hours ensued. General Mollard (commander of the 3d division) knew it was useless to attempt anything offensive without reinforcements, and Benedek left him undisturbed, partly to rest his own men after five hours work, partly because any advance would expose his left flank towards Solferino, where the issue was still doubtful.

The 2d Piedmontese division had formed a reserve at Lonato and San Polo, whilst the other three advanced as above related. At eleven o'clock it was ordered to strengthen the 1st division in its relations with the French, but at half-past one the critical state of affairs at San Martino caused one of its brigades (Aosta) to be immediately despatched thither from Castel Venzago.

It arrived at four o'clock, and Mollard prepared to re-open the battle. The Pinerolo and Aosta brigades were, as fresh troops, to attack in front, the Cuneo brigade to support, and the 5th division, recalled from San Zeno, was to extend the attack towards the left. One battalion, with some riflemen and two guns, went round to make a diversion on the right.

This new engagement was interrupted for a time by the storm. When it began again, the Pinerolo brigade took the scattered farm-houses one after another, between the railway and the heights;

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there they were checked again; but the order for Benedek's retreat had reached him, and he was obliged, however unwillingly, to give up the ground he certainly would not have been driven from.

About nine o'clock all firing ceased. Three guns, probably disabled, which the Austrians abandoned in their first repulse by the Cuneo brigade in the morning, and which had since been taken and lost over and over again, remained to the Sardinians as trophies of their success.

The first division, and Piedmont brigade of the second division, were pushed forward under the command of General La Marmora, after the evacuation of Madonna della Scoperta. They took the directions of San Martino and Pozzolengo, and reached, after some fighting, the vicinity of Rondotto. Benedek made good his retreat to Pozzolengo.

The Piedmontese casualties during the day were—

At San Martino: 5 brigades, 25,000 men engaged.

	Officers.	Men.	Total.
Killed	42	529	571
Wounded	137	2,769	2,906
Missing	0	1,130	1,130
	179	4,428	4,607

Nearly $\frac{1}{8}$th; a heavier loss than any French division suffered at Magenta, or any corps at Solferino.

At Madonna della Scoperta: 3 brigades, 15,000 men engaged.

	Officers.	Men.	Total.
Killed	7	113	120
Wounded	30	636	666
Missing	0	128	128
	37	877	914

Only $\frac{1}{18}$th of the number engaged; 830, however, belonged to the 1st division, being $\frac{1}{12}$th its strength.

Operations in the Centre.

It will be remembered that Baraguay d'Hilliers' (Ist) Corps, and M'Mahon's (IInd) Corps, set out from Esenta and Castiglione for Solferino and Cavriana respectively. As there was no good road between Esenta and Solferino, only L'Admirault's division went direct by Astore; Forey's and Bazaine's, with the artillery, marched through Castiglione, and the whole IInd Corps went along the Mantua road for four miles to leave the other unimpeded.

Both corps met the enemy at about five o'clock; but whilst L'Admirault and Forey advanced steadily towards Solferino, driving back Puchner's and Bils' brigades of the Vth Austrian Corps, M'Mahon, for the reasons before given, was restricted to holding the ground he then occupied. At half-past eight the Austrians in his front had increased so much that he foresaw an attack would soon be made, and formed up his corps to receive it. He deployed De Caen's division (formerly Espinasse's) at right angles to the road, with its right upon it; the first brigade of La Motte Rouge's division in continuation of the line towards Medole (held by Niel's corps), and kept the other brigade in reserve. The 7th Chasseurs à Cheval were behind the left flank, against which there was approaching a body of cavalry from San Cassiano.

These dispositions were hardly made when the Austrians opened a heavy artillery fire. Four batteries, 24 guns, were sent to the

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front, and replied to them with a most decided advantage. Whilst this artillery combat was going on, Generals Partouneaux and Des Vaux arrived with their two divisions of cavalry; they were placed in rear of the right. The accompanying horse artillery came into action, and completed the success of the batteries by taking the enemy's guns obliquely. The cavalry also made charges, in one of which 800 infantry were driven back on to the French skirmishers, who made them prisoners. This attack was made by the 1st Austrian corps.

The opportune arrival of the cavalry divisions also enabled M'Mahon to strengthen the 7th Chasseurs à Cheval on his left. The reinforcement was of service, for between ten and eleven Mensdorf's heavy cavalry, come up from Tezze, charged upon them. The infantry formed four battalions on the left of the line into squares, and the attack was repulsed with a considerable loss of life.

See Plate, No. 13. At eleven o'clock M'Mahon began moving La Motte Rouge's division towards Solferino. De Caen's was to follow him; but it was not till the Cavalry of the Guard was put at his disposal that M'Mahon could take the offensive, without leaving a dangerous interval between the IInd and IVth Corps. The arrival of these 36 squadrons put him at ease for the present with regard to Niel, and he had already established his communications with Baraguay d'Hilliers, whose movements must now be described.

Only Bils' and Puchner's brigade opposed his advance in the first instance. L'Admirault's division was checked for a time, but Forey's continued advance freed it. Soon after ten o'clock Solferino was threatened at three points: below San Martino, by L'Admirault's division; on the heights to the west, by d'Alton's brigade of Forey's division; and on the south, by Dieu's brigade, also belonging to Forey. The last brigade made an assault, but was repulsed; and for some time a heavy cannonade only was directed against the village.

About eleven o'clock the Imperial Guard arrived. The Voltigeur division was deployed 500 yards in rear of the Ist Corps, with the

See Plate, No. 13. Grenadiers behind it, in double column of divisions. As soon as this reserve was available, Louis Napoleon, who was watching the battle at this point, ordered a decisive attack. D'Alton's brigade, led by Forey, headed it on the right flank; L'Admirault stormed San Martino on the left. At first, there was little gained; L'Admirault got into the hamlet, but a heavy cross fire checked his further advance. Gaal's and Koller's brigade were joined with Bils and Puchner in defending the place, and the cemetery in particular

See Plate, No. 14. seemed an almost hopeless obstacle. It had high walls, was loopholed, and occupied the entire breadth of the narrow ridge west of the old tower. A strong body of Austrians also showed an intention of coming between L'Admirault and the Piedmontese, but it was stopped by the fire of six French guns.

The Austrians suffered a good deal from the attack, although they repelled it; they only retained the most commanding points, and were indifferently assisted by the VIIth corps; the main body of which remained inactive towards Cavriana and Foresto. A

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French battery was now brought up to 300 yards from the cemetery, and all guns on the heights concentrated their fire upon it. When a breach had been made, Bazaine's division was ordered to attack it. Manéque's brigade of Voltigeurs reinforced d'Alton; and about two o'clock the cemetery, Cypress Hill, and high ground about the castle, were all carried together. Four guns and two standards were taken, and half an hour afterwards the Vth Corps was in retreat towards Pozzolengo.

About that very time M'Mahon assaulted San Cassiano. He took it "in a moment," and one of the hills towards Cavriana was likewise occupied by the Algerian Tirailleurs and 45th regiment. From this, however, they were driven away twice. The enemy made another attempt to separate the IInd and IVth Corps; the Ist was not equally advanced towards Cavriana, and M'Mahon suspended for a time his forward movement.

He resumed it when the Ist Corps and Imperial Guard were ready to unite with him, and the whole moved along the heights in conjunction. The Voltigeurs were on the left, supported by a brigade of Grenadiers; La Motte Rouge and De Caen's divisions were in line with these,—the former on the slope of the hill, the latter in the plain; Forey's and Bazaine's followed; L'Admirault's remained at Solferino. Parts of the Vth, VIIth, and Ist Corps opposed them; the Prince of Hesse in particular took a leading part; but the Austrians were disorganized here, and small bodies of men, determined as they might be, could not long withstand such numbers.

Brunner's brigade (Ist Corps) was thrown back by De Caen. Mensdorf's heavy cavalry attacked the French flank, and were repulsed by the Cavalry of the Guard. Later still, some Austrian squadrons charged down upon the French mounted skirmishers, and passed, in doing so, the 11th battalion of Foot Chasseurs lying down in the corn. As the cavalry went by, the Chasseurs sprung up, and poured in a deadly volley upon them. Two French batteries completed their confusion, by firing upon them in flank. At half-past three the Prince of Hesse gave up all offensive attempts. The French met but little opposition to their further advance, and Cavriana was evacuated by superior command before they stormed it.

The French attempted little pursuit after the heavy rain which followed; but a brigade, accompanied by some guns, nearly cut off the Emperor Francis Joseph and his staff, who passed within 700 yards of them. By a few rounds half the Imperial Family might have been killed, but they passed without molestation.

Baraguay d'Hilliers' loss was severe: 235 officers and 4,000 men, being one-sixth of his corps. M'Mahon's was less, about one-ninth, viz.:—

	Officers.	Men.	Total.
Killed	19	192	211
Wounded	95	1,266	1,361
Missing	0	300	300
	114	1,758	1,872

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That of the Imperial Guard was not given, but must have been about 1,500 in all. Only the Voltigeurs were exposed to any hard fighting.

Operations in the Plain.

The two French corps which fought in the plain were equal in strength, and arrived equally early on the ground; but there was a great difference between the shares they took in the events of the day.

Canrobert's movements are easily described. He crossed the Chiese near Visano by a bridge which the Piedmontese engineers threw over it on the night of the 23d. Jannin's brigade was sent in advance to cover its construction, and the rest left Mezzano at about half-past two in the morning, Renault's division in front, Trochu's and Bourbaki's following in succession.

Castel Goffredo, occupied only by some enemy's cavalry, was easily carried about seven o'clock. At a quarter past nine, the leading division was within a short distance of Medole, and pressing demands for assistance came from Niel; but at the same time Canrobert received a letter from the Emperor, informing him that 25,000 or 30,000 Austrians had left Mantua on the 23d, and that their outposts were at the village of Acqua Negra, near the Chiese, ten miles off. Information from the country people, a movement of troops that way, observed and communicated by General de Luzy, and a train of dust then visible in that direction, corroborated the report, and Canrobert thought it not safe to send forward more than six battalions and two guns of Renault's division, which took up ground about 2,000 yards from Medole, on the Ceresara road, and slightly strengthened Niel's right. The guns in particular were of service, by firing on the Austrian columns as they advanced to the attack.

See Plate, No. 13.

At three o'clock he sent the whole of Renault's division to the left; eleven of its battalions to strengthen the line at Rebecco, the other two to occupy Medole. At four o'clock Bataille's brigade of Trochu's division proceeded towards Baete, and at last, but too late, Bourbaki's division was likewise detached. Collineau's brigade of Trochu's division still remained to watch the Acqua Negra road.

In 25,000 men, Canrobert had only 250 casualties; amongst them were three officers killed, and twelve wounded.

The fighting was sustained almost entirely by Niel, who gained ground against forces much more numerous than his own; he had, however, a great superiority in cavalry, and his artillery overmatched the guns sent against him.

His order of march was, Luzy's division in front, Vinoy's next, then the artillery, and lastly De Failly's division; the whole preceded by two squadrons of Chasseurs.

Medole was held by Count Zedwitz with ten companies of infantry and six squadrons of cavalry. De Luzy attacked it under cover of artillery fire, and had taken it by seven o'clock. The Austrian infantry retired towards Rebecco, followed by Douay's brigade; three battalions of the other brigade took the road

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towards Ceresara. Zedwitz took the six squadrons of cavalry to the plain, where he expected to find Lauingen with the rest of the brigade, and four other squadrons, sixteen in all; but the latter was nowhere to be seen. Zedwitz himself went in search of him, and between the two the Austrian left wing was deprived of its cavalry and horse artillery.

When Niel had emerged from Medole, he saw strong columns of the enemy which threatened to surround him. They consisted of the IIIrd Corps, and half the IXth; the former was along the Guidizzolo road, with some battalions at Casa Nova, the latter at the village of Rebecco. In course of the morning they were joined by the rest of the IXth, and four out of the five brigades composing the XIth Corps, then further back at Castel Grimaldo. Niel had therefore to contend against twelve brigades, more than double his own strength.

De Luzy's division being employed towards Ceresara and Rebecco, Vinoy's was sent to the left, and, having taken the farm called Casa Nova, deployed with its left thrown back, in the direction of Casa Marino, a mile and three quarters off, which M'Mahon then occupied. When M'Mahon began to advance on San Cassiano, Vinoy's division, pivoting on Casa Nova, followed his movements. The reserve artillery and Partouneaux's and Des Vaux's cavalry strengthened the interval between them. See Plate, No. 13.

The enemy soon tried to penetrate it; but the artillery, which had 42 guns in action at this point, checked his advance by a heavy fire, and the cavalry made some charges with good effect. At Rebecco the French were soon engaged with the whole IXth Corps, and the few reserve battalions at Medole were sent up one after another. When De Failly's division had passed through Medole, O'Farrel's brigade was placed at Baete to strengthen the connection between De Luzy and Vinoy, and Saurin's brigade was kept to form a fresh reserve.

For six hours, from nine to three, the fighting continued on the same ground. On the left, artillery performed the principal part, in which, Neil writes, "we had always an incontestable superiority." Elsewhere he says, "When the combat was carried on by the fire of the infantry, I lost ground, the enemy having the advantage in numbers. Then I formed a column of attack with one of my reserve battalions, and gained more by the bayonet than I had lost by the musketry fire."

At three o'clock the first instalment of Canrobert's assistance, Renault's division, came to the front. Niel immediately sent four battalions of De Luzy's and two of De Failly's division to attack Guidizzolo. A battalion of the 30th line regiment, leading the column, reached the first houses of the village, but meeting there the troops formed for a general counter attack, (as before related,) the French were repulsed. Nevertheless, with the arrival of half Trochu's division (Bataille's brigade) at four o'clock, and the prospect of Bourbaki's likewise joining him, Niel made another attempt to possess himself of Guidizzolo.

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Bataille's brigade, formed in echelon by battalions in close column, advanced to the assault. It had traversed half the distance, taken two guns, and made a whole company prisoners, when, to use Niel's words, "a violent storm, preceded by whirlwinds of dust which plunged us in darkness, put an end to this terrible struggle."

Canrobert's loss has been given, $\frac{1}{10}$th of his strength; Niel's was equal to that of Baraguay d'Hilliers, $\frac{1}{6}$th of the strength; viz.:—

	Officers.	Men.	Total.
Killed - -	38	523	561
Wounded - -	185	3,236	3,421
Missing - -	3	373	376
	226	4,132	4,358

Out of this number, the artillery had 4 officers wounded, 8 men killed, and 65 wounded; total, 77.

The two cavalry divisions lost, in addition to the above,—

	Partouneaux.			Des Vaux.		
	Officers.	Men.	Total.	Officers.	Men.	Total.
Killed -	1	12	13	- 7	51	58
Wounded -	7	44	51	- 15	137	152
Missing -	0	4	4	- 4	38	42
	8	60	68	26	226	252

The report of General Niel gives more detailed information on this subject than any of the others.

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CHAPTER IX.

Review of the Battle and Termination of the Campaign.

The Austrians retired in good order; rear-guards held Pozzolengo, Corte, and Guidizzolo till ten o'clock, and the army reached the left bank of the Mincio without molestation. It may easily be understood that the Allies, after seventeen hours' marching and fighting on the 24th, must require rest on the 25th, and there could be nothing gained by a pursuit when the Austrians were so close to their fortresses.

The total loss of the Allies was about 18,000 killed, wounded, and missing; of the Austrians, 22,000, among whom, however, were 9,300 missing, a great part of which may have returned afterwards. It is likely that many deserted, as the Croat and other battalions were politically disaffected.

Four Austrian generals were wounded,—Crenneville, Blomberg, Palffy, and Baltin. In the French army, General Auger was killed; L'Admirault, Dieu, Forey, and Douay (three of them in the Ist Corps) wounded. Two Sardinian generals were wounded,—Cornaldi and Anfaldi.

There is a great discrepancy between the number of guns which the Austrians confess to having lost (13), and the number which the French claimed to have taken (30). The commanders of corps reported having captured,—Imperial Guard, 13; Ist Corps, 4; III^{d}, 2; IVth, 7. The *Piedmontese Gazette* states, that at St. Martino were taken 3; these amount only to 29, and the corps which were acting together perhaps counted some twice over.

Francis Joseph's military counsellors had differed about the advisability of leaving the Mincio line at all. Count Hess was strongly opposed to the step, and it is said that he would take little or no part in executing it. Lieutenant Field Marshal Ramming principally made and superintended the arrangements. The general design of tempting the Allies to advance carelessly, and of then suddenly turning upon them at the Chiese, was good; and a decisive victory would have restored all they had lost, for the Allies had no defensive position in all Lombardy to fall back upon. The Austrians generally are too slow to succeed in such movements, and this was resolved on too late.

The baggage and stragglers which followed the army to the Mincio still encumbered the roads when the columns commenced their retrograde marches. This caused some delay and confusion, but they reached their intended stations on the night of the 23d. So far they were well placed for anything that might occur; but had

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no instructions in case of an action, as if there were no *possibility* of the Allies being a few miles nearer than they were calculated to be.

Under these circumstances, the want of command in the Austrian forces, compared with the fixed purpose and steady handling of the French, would be sufficient in itself to account for their defeat; but other causes are to be found in abundance. The Commander-in-Chief had not, like his rival Emperor, the skill to form a plan suitable to the altered circumstances, or the ability to employ the several parts of such a vast army in the furtherance of it. The inferior commanders evinced similar want of decision, employing single brigades here and there, in the most likely manner to lose control over them. Zobel did nothing with his united corps for want of orders; the Prince of Hesse, on the other hand, employed his division without orders for the defence of Cavriana, and by delaying its capture probably saved the army from a great disaster. Clam Gallas unaccountably lost his artillery reserve, and Lauingen took off his brigade at a trot to Goito, as soon as M'Mahon's skirmishers approached.

To this defection a greater importance is generally attached than it deserves, it being supposed to include all Zedwitz's division, of which one half was at Gazzoldo. The *Edinburgh Review* puts it at 15,000 men and 36 guns. The whole cavalry of the left wing (including the regiment attached to each corps, as well as Zedwitz's reserve) on the field amounted to only 28 squadrons, or about 4,000 mounted men. Its presence in the early part of the day would have added to Niel's embarrassment and difficulties, but would not have changed the grand result. Much more importance may be given to the fact that the men, surprised before they had prepared the morning meal, were committed fasting to a long day's work.

Another great impediment to the handling of the army was, that the Commander-in-Chief had no reserve troops under his own orders. If the generals of the 1st and 2nd armies were to wait for all instructions from him, the only effect of their presence would be to create a delay in the transmission of every order. If they had independent control over the armies, the Emperor could never rely on men being available for carrying out his intentions. This defect showed itself strongly, for when the Emperor ordered in the afternoon an attack on the Allies' right, there was only one fresh brigade in that part of the field.

The judicious direction of the Imperial Guard gave the French an advantage in numbers at Solferino in the proportion probably of seven to four, although they did not employ the whole; but the Allies and Austrians being of equal strength, a superiority could hardly be obtained at one point, without leaving a deficiency in another; and accordingly, as M'Mahon drew near to the hills, Niel had to sustain himself against three Austrian corps, having only a numerous cavalry in his favour.

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Niel was in a worse position than he need have been, owing to Canrobert's unwarranted inactivity, for which Louis Napoleon was not to blame. The caution he received about the possible attack on the Acqua Negra side certainly did not justify his keeping the whole corps idle for six hours; he might soon have ascertained there was no immediate prospect of it; and by guarding against a possible contingency in such a way as he did, he exposed Niel to a great and immediate danger.

The casualties among the field batteries amounting to 77 in Niel's corps alone, whilst at Magenta those of the whole artillery were only 28, shows how much more important artillery had become with the altered nature of the country. There can be no doubt that in this action the rifled cannon gave a considerable advantage. At Solferino they played on the village with effect (nicht ohne Erfolg) from a distance of 2,500 yards, and the guns which stopped the Austrian column from turning the Sardinian right must also have fired at a considerable range. The cemetery, though nothing but a square enclosure, with four high loopholed walls, secured the position until it was reduced by artillery. Guns were brought to breach it at 300 yards distance, under a continued infantry fire. With a gun so accurate as to hit a man on horseback at two miles all but a furlong (3,100 mètres), one would suppose that the necessary damage could have been done from a safer distance. Certainly neither the strengh of the walls, which are mere rubble plastered over, nor the nature of the ground, necessitated such a hazardous approach. After all, the "sufficient breach" probably meant that the gates were knocked down, for the holes in the wall, which were still unrepaired in October, would only admit a couple of men at a time with difficulty. (*See* Sketch.)

See Plate, No. 14, and Frontispiece.

The Austrian guns, retiring from the small plateau near the foot of the tower, had to descend by a narrow road; one of them caught against a post and upset; three more were then unable to pass, and all four fell into the hands of the French. A colonel of artillery was made prisoner with them, and gave up his sword to a lieutenant of the Imperial Guard.

See Plate, No. 14.

From the foot of the hills to Casa Nova, along M'Mahon's and part of Niel's line, the action was confined for some hours to artillery fire, with episodes of cavalry charges. M'Mahon reports 24, Niel 42, guns engaged; horse artillery also took a part, and there must have been at least 78 guns drawn up for action together; no wonder that the 1st Austrian corps fell back to San Cassiano without making any serious attack, and before it was entirely brought up.

At one point, where it was necessary to withdraw an Austrian field battery out of fire on account of its being overmatched by being opposed to three French ones, an eye-witness* describes the affair thus:—Mensdorf's cavalry, and a battery of horse artillery were ordered to advance and cover its retreat; they had hardly got

* Edinburgh Review.

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within 1,700 yards, when, of six guns, five were dismounted. Another battery was sent up; in one minute from starting, three were dismounted, and 500 horses were killed. In the meantime the artillery had been withdrawn.

After the battle of Solferino, the Austrian main body retired to Verona, where it occupied both sides of the Adige, and the country towards the Lake of Garda. Garrisons were of course left in Peschiera and Mantua, but Louis Napoleon had the passage of the Mincio left open to him. The events of the 24th had delayed, but not altered the course of his movements; and his divisions occupied that night almost the very places proposed for them when no battle was expected. In some respects he was a gainer by it; the enemy had suffered a greater loss in men and material than himself, and a new victory had raised still higher the confidence of the French soldiers.

On the 28th June, Niel's corps crossed the Mincio and advanced towards Villa Franca; M'Mahon's and the Imperial Guard occupied Valeggio; Canrobert's was at Goito; Baraguay d'Hilliers supported the Piedmontese, who were beginning to break ground for the siege of Peschiera.

There the brothers Godard made several balloon ascents, accompanied by engineer and artillery officers to examine the defences of the place; and it was rumoured that as the siege advanced, shells would be carried up and dropped over the fortress by this means.

In the meantime gunboats, constructed in separate pieces, so as to be sent by land and put together afterwards, had been prepared in France and sent to Salo, on the west shore of the lake. Each carried one long gun to fire over the bows, with an iron shield before it. They were built so as to steam with equal ease backwards or forwards, and by running straight in or out they would present a very small object to aim at. One of the Austrian war steamers, proceeding to reconnoitre Salo on the 21st June, was set on fire by the batteries on shore. The captain was obliged to run his ship over to San Vigilio on the opposite side of the lake, and sink her there.

Seventy miles to the north-north-west Garibaldi's corps, supported by the 4th Piedmontese division, skirmished with the VIth Austrian Corps, which occupied the western Tyrolese frontier from Glurns on the Adige to Riva on the Lake of Garda. At the Lake of Idro on the 24th June, and at Bormio on the 2nd July, there were encounters between the outposts. At the end of June a body of 5,000 men was assembled near Tirano on the Adda, and on the 7th July two unsuccessful attacks were made on the Austrians between Bormio and Glurns, at the pass called the Stilffer Joch.

In the south of Lombardy, Prince Napoleon had brought up the Vth French Corps out of Tuscany. The first of the two divisions which composed it was landed on the 12th May at Genoa, and put for a time under Baraguay d'Hilliers' command. One of its

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regiments, the 93rd, was present, though not engaged, at Montebello; another, the 3rd Zouaves, was sent to Bobbio, on the Parmese frontier, twenty miles south of the Po. When the Austrians no longer threatened that side, the regiment was withdrawn, and being then sent up with Canrobert to Vercelli, took a distinguished part in the battle of Palestro.

The other division of the Vth Corps was conveyed direct from Toulon to Leghorn. The whole corps marched into the interior; and on the 31st Prince Napoleon established his head-quarters at Florence, where he remained till the Austrians retreated from Magenta. His presence in the Duchy had rather a political than a strategical object.

When the Austrians' intention to abandon Lombardy became evident, the Prince was ordered up to the Mincio. His march began on the 11th June; a Tuscan division under General Ulloa accompanied it. Autemarre's division was pushed forward, and reached Piadena on the 23rd, as already mentioned. On the 28th the head-quarters were at Parma; on the 30th the Po was crossed at Casal Maggiore, and on the 2nd July the three divisions were united at Piadena. Thence they went to Goito, where the Prince had his head-quarters on the 4th July.

The Austrians were expecting soon to be joined by their Xth and IVth Corps. From France also fresh divisions had been ordered to Italy. In the meantime operations against the Quadrilateral were begun. Prince Napoleon was to keep the garrison of Mantua in check, and the main body to watch the neighbourhood of Verona, whilst the Sardinians conducted the siege of Peschiera.

Such was the state of affairs in the two armies when Lieutenant Field Marshal Urban, Commandant of Verona, came on the 2nd July to Louis Napoleon's head-quarters at Valeggio. Prince Windischgratz had fallen at Solferino, and his family was anxious to learn particulars of his fate. Rumours that Napoleon would be glad to conclude the war, if possible, had been in circulation since the middle of June. This interview gave him an opportunity of hinting his readiness to accept terms, and messengers passed to and fro during the next three days. On the 6th Count Fleury, his adjutant, visited Verona; on the 7th he returned, accompanied by an Austrian officer; and on the 8th July was arranged the truce which, followed by a peace, terminated the Italian Campaign of 1859.

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CHAPTER X.

Concluding Review.

When the war began, Louis Napoleon declared his intention of "freeing Italy from the Alps to the Adriatic;" his part was, therefore, distinctly aggressive, and his operations would depend on the Austrian attitudes, as the latter had the start in opening the campaign. The Austrians' object was to humble the Piedmontese; but expelling them from Italy was out of the question; their operations must, therefore, sooner or later assume a defensive character.

The Ticino and Po offered the best natural barrier. Bridges can hardly be thrown across a river under artillery fire; and if the enemy's vigilance is sufficiently deceived to accomplish as much, it still remains to take up a good position for fighting on the opposite side. The Po could not be passed anywhere without a bridge; the Ticino was fordable in places, but was strengthened by the great canal on its eastern side. Further up, it issues from the Lago Maggiore, which was commanded by Austrian steamers.

Perhaps it was intended to keep the Ticino for a second line of defence; at any rate a field-work was made at San Martino to cover the bridge there. In the meantime the Austrians took up a position along the Sesia, in which they could maintain themselves at the enemy's expense.

The stories which were told of their excesses and cruelties at this time were wanton fictions to excite the people against them. A French correspondent, who had forwarded to the *Débats* reports of peasants forced to labour by Austrian corporals "à coups de bâton;" of women and children snatched from their homes, and put in front of working parties to save them from being fired on; of hospitals robbed of their linen and necessaries, with many similar barbarities, afterwards writes from Vercelli thus,—

"Encore une désillusion . . . . . heureuse tout au moins! Je suis au cœur du Vercellais, dans le chef-lieu de la province, et je ne peux voir aucune trace de ces dégâts dont tant de récits ont fatigué la presse. Je cherche, je regarde, j'interroge; rien, toujours rien. Les boutiques regorgent de marchandises, les hôtelleries n'ont rien perdu de leurs batteries de cuisine et de leur vaisselle, aucune famille n'est en pleurs. Tout s'est borné à Verceil, comme à Voghera, à des réquisitions de bœufs, de pièces de vin et autres approvisionnements, ce qui s'est toujours fait en pays ennemi." He proceeds to say, that at leaving the place some outrages may have been committed, but laments that such mischievous, ill-grounded reports should have been circulated.

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The position on the Sesia was turned at Vercelli, and the outposts at Palestro completely surprised. The Austrians attributed much of their overthrow in the campaign to want of information, which, as the country was disaffected, if not hostile, is to a certain extent admissible; but the peasants were not very zealous in the Italian cause, and money will generally procure intelligence. That large bodies of troops should be so close as the French and Sardinians were on the morning of the 30th May, and no notice taken of them, reflects discredit on the army itself.

The Ticino line, adopted when the Sesia had been turned, was hardly taken up when it was attacked and carried. No other between Milan and the Mincio offered sufficient advantages to stop their retrogression; and the more the Allies were tempted forward, the more serious to them must a defeat become.

Hardly, again, was the army ranged along the Mincio, when it returned over 15 miles of the same ground to try the effect of a sudden attack. Instead of surprising the Allies, it was, in fact, surprised itself; the collision took place a day sooner than calculated upon. The men were unprepared even for a march when the battle began, and the result left the Austrians, as the morning found them, very much in the predicament they had intended for the French.

In action the army did not fulfil the expectations of impartial observers, although its partisans extolled the bravery of the soldiers more and more after every defeat. A comparison of the forces engaged shows that where the Austrians had superior numbers, in plain hand to hand fighting, they achieved nothing.

The arm in which they take most pride is the cavalry. This they had no opportunity of using to advantage till they came to Solferino, where the defection of Lauingen reduced their numbers too low. A few dashing charges, without any important result, were all that the cavalry did in the war.

The Austrian artillery was considered hardly less excellent than the cavalry. At Magenta it seemed to do hardly enough: at the first two actions, to have had as much effect as would have been expected, considering the nature of the ground. At Solferino the rifled cannon overpowered it.

An Austrian officer of rank spoke of the three arms thus:—"Our cavalry was magnificent, our artillery excellent; the enemy styled them so; but our brave infantry fellows have not the dash or quickness of the French; they stood up to be shot at."

The Jägers were, however, held in high respect by their adversaries as good skirmishers and excellent shots. No doubt, too, that many infantry regiments fought well, but there were also many without the will to exert themselves. Italian regiments, which happened to be in the corps ordered for the service, were exchanged from them. One was sent at its own request (Archduke Sigismund regiment) and fought at Magenta, where it left, as was said, many willing prisoners behind it. Neither was this disaffection confined to the Italians; regiments from Hungary, Sclavonia, and Croatia shared it.

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The Piedmontese fought well at Montebello, but only a thousand of their cavalry were concerned. At Palestro their numbers predominated too much for any conclusion to be drawn. At Magenta their share was confined to a battalion of Bersaglieri and four guns, which arrived when the enemy was beaten. At San Martino the men fought well, but the manner in which they were employed invited defeat.

There was jealousy, as usual, between the allied armies; each spoke in private disparagingly of the other: it cannot, however, be denied that the French well sustained, and even increased their reputation.

It is generally supposed that certain picked regiments, such as the Zouaves, were always sent to the front. This impression vanishes on examining the detailed accounts.

There were three regiments of Zouaves: one in Bazaine's division, Ist Corps; one in Espinasse's division, II^{d} Corps; and the other in the Vth Corps. At Montebello none were engaged. At Palestro the 3d Zouaves came into action by chance. At Magenta, the 2^{d} regiment, being in Espinasse's division, did not engage till long after those of La Motte Rouge's. At Malegnano the 1st Zouaves led the attack of Bazaine's division, and at Solferino again; but at the latter place it was not brought forward till about one o'oclock. In this division it was substituted for a battalion of Chasseurs, and therefore naturally headed the advance.

The Grenadier division of the guard was sent up first to the bridges at Magenta, but the Voltigeurs attached to M'Mahon kept in rear till late in the afternoon; at Solferino the whole corps was in reserve, and only a part actively employed. That Zouaves or picked regiments would be selected for any particular service which needed few men and required a bold attack, is very probable: but it does not appear that in this campaign they were exposed for the sake of setting an example to the rest.

The *Times* correspondent, in his late letters on military organization, has highly eulogised the French infantry both in camp and field. Of their excellent organization there can be no doubt; but his statement that these battles were won by their skill in skirmishing (though very like the Austrian officer's confession) is unsupported by the necessary facts.

Their quickness in moving would tell *physically* by being able to bring a superiority of numbers to any point, but much of their success was gained without this. *The true test of skirmishing is the proportion of loss inflicted to loss suffered;* and the lists of killed and wounded show plainly that their firing was not more fatal than that of the Austrians. The difference, where noticeable, is no greater than always exists between a defeated and victorious army, and is almost a necessary consequence of a retreat in face of the enemy.

If his sweeping condemnation of the Austrian artillery is to be accepted as conclusive, the figures will tell still more against his favourite skirmishers; for if "the respectable old yellow war engine" was so "positively ridiculous," the Austrian infantry must

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have caused the whole loss,—a loss equal to that from the French rifled cannon and rifled muskets put together.

Morally, the quickness of the French advance may have had a great effect, for the Austrian soldier, finding them close so quickly in a charge, would be apt to lose the coolness and self-possession which were necessary to meet it. But the truth is, that the French always have, with any weapon, maintained a character for dashing attacks; it is noticed by a chronicler who wrote 300 years ago.

The new rifled cannon were reported by the French to produce magnificent results, but this was not endorsed by the Austrians, who might have made them an excuse for being defeated. The first employment of them was near Valenza against a house at 2,500 métres (2,700 yards). At the 30th shot "la maison s'ecroulait" (French correspondent). On the spot we were shown the house, and told that it was hit. When the story reached Marseilles, it was no longer a house, but "fortifications," and "reduced to ruins in five rounds."

Their real power could hardly be observed in the first battles. At Solferino their effect was unmistakeable, but the fuzes, which are an equally new invention, often failed. French officers accounted for this by the suddenness of the demand causing them to be hurriedly prepared. The batteries were not all armed with rifled cannon; smooth bores were being embarked at Marseilles on the 25th May and 6th June. 100 rifled guns were forwarded to Italy from Paris on the 18th June.

The non-combatant departments seem to have done their work effectually, and were aided by wise precautions being adopted. Every article of baggage that could be spared was sent into store at Genoa before the flank march began. The men never started of a morning without having had coffee, and officers as well as men carried one day's provision with them.

The electric telegraph was brought into play, and followed the army as it advanced. No time was lost in laying it down; Novara, for instance, was occupied on the 1st June, and that same day the wires to connect it with Vercelli began to be fixed.

The employment of a balloon is also noticeable, though not unprecedented; it was frequently used by the French about the end of the last century.

For Louis Napoleon the campaign was a triumph: he proved his ability as a general, strengthened his position in France, and won the confidence of the army. His measures are quite open to criticism, and, with a different opponent, would not have succeeded so easily as they did; but it may be said that it is part of a general's skill to suit his tactics to the antagonist he has met.

The commanders of corps, with one exception, supported him well. M'Mahon got more credit at Magenta, perhaps, than he deserved. It appeared at first sight as if the flank movement from Turbigo was suggested by his own discernment, and arose out of the exigencies of the front attack it was in reality a most important part of the original plan.

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Canrobert missed a chance of distinguishing himself at Palestro; nearly lost a battle by coming up late at Magenta; and showed a caution amounting to timidity at Solferino. He had served a good deal in Africa; but his advancement was due to political causes, rather than military ability. He was the youngest of the French corps commanders.

Of the Austrian corps commanders, Benedek showed most energy and skill; Clam Gallas and Zobel rather distinguished themselves for blunders; Liechtenstein, at Solferino, played a similar part to Canrobert; Stadion failed at Montebello; Lauingen (general of brigade) was sentenced to ten years' imprisonment in a fortress for his defection at Solferino, and Zedwitz, less to blame, was deprived of his command.

The commissariat was undoubtedly bad. The prisoners from Jellachich's division at Palestro said they had not eaten for two days. (It will be remembered that this division marched fifteen miles to the field.) They "threw themselves" on the bread that was offered. At Magenta the same want of food impaired the energy of the men, and at Solferino bad arrangements brought them fasting into action.

Almost to the end of the campaign the soldiers were unnecessarily burdened with useless things, only required for parade. When the Emperor took command (18th June) an order in the other extreme was issued,—that the knapsacks should be carried for them. When a man's necessaries are once separated from him, the delay and trouble in re-issuing them are likely to be more detrimental than the fatigue of carrying them. Moreover, if want of transport had any share (as it must have had) in causing want of food, the increased demand for animals and waggons to carry the knapsacks would make it far worse.

If this campaign added nothing new to military science, it at least furnished fresh illustrations of some old truths,—especially,—That on an accidental feature of the ground may hang the fate of a battle;—That troops should be brought into action by masses, and not by small bodies;—And that it is almost as important to have soldiers well fed and well accoutred, as to have them on the ground at all.

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Considerations and Suggestions relative to the Magazine, Storage, and other similar requirements of Permanent Garrison and Coast Batteries. By Lieut.-Colonel NIXON, R.A.

[Read March 16, 1860.]

FREQUENT complaints are made by the Artillery on account of the defective engineering arrangements observable in our permanent batteries, both coast and garrison; none of which require more to be reformed than the distribution and supply of the magazines, store rooms, and other similar requirements for facilitating the service of the ordnance.[1] A marked absence of *system*, in common with other defects, is observable in these arrangements; so marked, indeed, that a natural conclusion to be arrived at on the subject is, that the projectors and constructors of our permanent batteries have been, and must still be, very uninformed of the real wants of the Artillery; a result, in fact, fully to be expected from the hitherto, well-known and allowed neglect of an earnest and effective co-operation between the ordnance services in all defensive arrangements.[2] This defect, long felt by the artillery, has been of late years remedied in a small degree—only in a small degree; for the true position of the artillery officer in his professional relation to and dealings with the engineer is obviously not yet fully recognized; and the latter, in consequence, still acts in entire independence of him, in determining matters of detail, in which he is, from his position, the most interested and the best informed; a method of proceeding defective in the extreme, and which never could produce satisfactory results for either service, but quite the contrary; and too often, moreover, places both in a discreditable light in the eyes of uninitiated lookers on, ignorant of facts not apparent at the moment, and for which neither service is fairly responsible.

Under such circumstances it is not to be wondered at that defects are found abounding in the arrangements of our batteries,—defects the more mischievous as there is, under the present system, but little probability of their being remedied, until an attack upon our, as yet untried, defences by a powerful enemy points out the necessity for it when it is too late.

It is only in some of the more recently constructed and remodelled batteries that signs appear that the subject, herein under consideration, has been at all duly attended to. Yet even in these are observable such deficiences and defective arrangements that, to a practical artilleryman, it would be evident that the ordnance, however perfect in itself and in its equipments,

[1] It is not the object aimed at here to add another voice to the many which have been raised from time to time, against the Royal Engineers. They, in their own way, are as much sufferers from a vicious system, as the artillery are in theirs; and any want of information shewn by them in connexion with the subject of this paper must, in justice, be considered as more their misfortune than their fault.

[2] An officer to whom this paper had been shewn when completed, added here:—"No less than from the constant temptation the latter service" (the engineer) "must be under, in the necessity of reducing expenses of construction to the uttermost, to make requirements, whose importance it appreciates imperfectly, give way those it best understands." This may be the case; but still it is the very fact of the want of co-operation between the services that leads to most of, if not all, the practical ill effects of the present system. Had the artillery officer a voice in the matter beyond the mere armament, his views as regards the requirements of his own service, would be a guide to the engineer, and a counterbalance to check his inclination (if it existed) towards giving way to the temptation referred to.

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and good the *personnel*, could not be served in action against an enemy, particularly in situations where it would be open to an attack from shipping, in the most effective manner; and that on occasions of sudden attack there would be great delay and confusion in getting it into action at all. It will, therefore, not be perhaps—especially in these days of great and costly additions to our material coast defences—considered superfluous on the part of the writer to endeavour, in the few following pages, to aid in drawing general attention to this very important subject, which deserves far more practical consideration than it appears ever to have received in our service. An omission the evil of which, if not remedied in time, will be seriously felt from the first moment of an attack upon our imperfectly prepared defences. Indeed, the writer cannot conceive how an effective fire could be maintained against an assailant by our batteries, on our seaboard especially, under the existing arrangements, or rather, mal-arrangements complained of; he can see no other result for the artillery serving them, in general, but defeat.[1]

In the following pages the writer proposes to express his views on what he considers to be the requirements, of the nature under consideration, of garrison and coast batteries for their due service against an enemy; and which, if complied with, would remedy the defects above complained of. In effecting this object it will be necessary often to enter into very minute details which, to some readers, may appear to be trivial; yet, nevertheless, are in themselves of very great importance, as constituting parts of the whole subject, and without which it would not be complete; or the methodical arrrangement desired by the writer, and so necessary in all artillery arrangements, be attained.

Setting aside, in considering this subject, all reference to our batteries in respect to the merits or demerits of their construction, and also with regard to the efficiency or otherwise of their artillery means,—their matter of course specialities, properly speaking, as not entering directly into the subject to be discussed, there remains to be stated what more is requisite to be prepared beforehand, in order that our batteries may be brought into action and served by the *personnel*, when needed, with the fullest effect.

Gun and howitzer batteries.

And first, with respect to gun and howitzer batteries. Their requirements, of the nature under discussion appear to the writer to be comprised in the following seven details of construction, which may be termed battery fixtures:—

Details required. See plate.

(1) Expense magazines.

(2) Expense shell stores.

(3) Expense grape and case stores.

(4) Rooms for filling shells and fixing fuzes.

[1] This hopeless view of matters may be disapproved of by some readers. Yet let them consider for one moment the only true method (in its application to our batteries) of estimating the value of defensive arrangements, viz. the comparative perfection of the means and system of offence of a probable assailant, and probably they will be then more inclined to agree with the writer. Our batteries on our landward defences would have a better chance—possibly, and even probably, of success; but those which are open, from their positions, to the attacks of an adequate force of shipping, are as hopelessly defective, in general, as above stated.

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(5) Shelter for the small stores, and side arms.

(6) Shelter for moveable shot furnaces, (for solid shot-guns, on coast batteries).

(7) Shell recesses.

That the above are necessary requirements will no doubt be conceded.

What has to be considered.

There is now therefore but the question of number, design, and arrangement to be considered, and which question is precisely that which, in its application, has been so much neglected in our service.

In considering the number, design, and arrangement of the preceding details (omitting No. 7 for the present for the sake of convenience), the subject divides itself into the following heads:—

Heads of subjects to be considered.

(1) Number.

(2) Position.

(3) Form and dimensions.

(4) Interior fittings.

Each head will now be considered separately:—

1st head,—*Number.*

(1) *Number.*—The number of pieces of ordnance to be served, and their relative positions on the works are the considerations which must guide the decision under this head. Short intervals between the ordnance and their sources of supply being a principal object to be attained.

The ordnance should be divided into groups, according as it is distributed along the works; and for every group one of the preceding details should be provided.

The number of pieces of ordnance in each respective group will of course vary according to the form, extent, and position of the work, or of portion of work, in which they are mounted. In some they may consist of but few pieces, as in minor outworks and small coast batteries. In others, of several pieces, as in bastions and on long lines. Under the latter circumstances, where the number of pieces exceeds ten or twelve, it would be better to divide them into two or more groups, according to the length of the line on which they are distributed. In fact, no group should exceed ten or twelve pieces in any position; for beyond those numbers (bearing in mind the necessary intervals between the ordnance), however central the expense magazine, &c. might be with respect to the battery, the pieces on the flanks would be too far off to be conveniently and quickly supplied from them. The ordnance is even sometime so scattered, that not more than a very few pieces could be conveniently supplied from the same source.

See Fig. 1 of Plan.

In coast batteries, especially in those open to the rear, it has been often *thought* necessary to construct the expense magazines, shell stores, &c. in the traverses of the work, or in the epaulments. Here they are necessarily small; and it has been, therefore, requisite to construct several of them for a comparatively small number of pieces of ordnance. Such are special cases,

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which cannot be subjected to any other general rule, under this head, than that the details under consideration, in such localities, should be sufficiently numerous to meet the full requirements of the battery, with a view to convenience and rapidity of supply. There are, however, positions in which coast batteries, open to the rear are found where, (from the features of the ground and the nature of the approaches by sea combined, allowing of shelter from direct and flanking fire being obtained close in rear of the ordnance), one of each of the preceding details might be constructed large enough to suffice for the service of the whole battery, if not of too numerous pieces,—otherwise they must be multiplied in accordance with the rule above laid down. Such positions as these last are generally to be found on rocky coasts and shallow shores. Under no circumstances should any consideration of expense be allowed to interfere with an ample number of the details under consideration being provided, to meet the full demands of the artillery, more especially in those batteries constructed with the object of opposing attacks by shipping. Ships of war have all their materials of offence so concentrated within themselves, and so conveniently placed for immediate service, enabling them also to maintain the utmost possible rapidity of fire, that it is imperative that batteries subject to their attacks should be furnished abundantly with every needful means to meet them on an equality. If the circumstances of any battery were such as to demand a magazine for every piece (though certainly not a likely event to arise) it should be supplied, so important is it that everything desirable should be furnished unsparingly. The question of expense being allowed to carry overweight with it in this direction, might nullify the efficiency of a battery in other respects all that could be desired.

2nd head,—*Position.* (2) *With respect to Position.*—The best position for these constructions will of course depend, in a great measure, upon the plan of the battery or of the work of which it forms a part; the lay of the ground; and the cover which both combined would afford. These circumstances varying greatly, according to locality, render it difficult, and sometimes impossible, to find a position combining every advantage desired to be attained. Still, much better positions might have been selected, than has been the case, in many instances which have come under the observation of the writer.

See *A* and *B*, Fig. 1 of Plate. In the selection of a site, the points to be attained and therefore held in mind are:—a central and proximate position with respect to the battery; *easy* communication to and from it; shelter from an enemy's fire; and a convenient position relatively to each other, with a view to a proper supervision and care of their contents, and the issue of the latter, when required for action, with promptitude and safety, combined with the employment, in the service, of the fewest men possible.

In forts and larger fortified places the most advantageous position for them would be in rear of the rampart; for there they would be most sheltered, and least in the way of the working of the battery; and, moreover, there the destructive effects of an explosion of the magazine would be of the least consequence. It is a most objectionable practice constructing the magazine *in* the battery and adjoining the ordnance, when it can be avoided; as an explosion either from carelessness or accident within it, or the

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enemy's fire, would almost inevitably silence the whole of the ordnance, and produce a most demoralizing effect upon the artillery. Yet, nevertheless, without any local necessity for it whatever, magazines are frequently seen in such situations.

In open coast batteries, very often, some of these constructions, such as the magazine and shell-store, are found in the traverses and epaulments of the work; probably owing to the impossibility of finding natural shelter for them, from either direct or flank fire, in any spot sufficiently near to the battery, in its rear; and from the wish to avoid the additional expense of throwing up the artificial cover which would be required for them, if erected in rear of it, under such circumstances. This last, if ever the actuating motive, must necessarily be considered a very unwise policy; for the objections already mentioned to the creation of a loaded mine, such as a magazine stored with gunpowder would be, in a battery, stand good under all circumstances of position. An old saying, true in its fullest application, informs us that "whatever is worth doing at all, is worth doing well;" and here its application tells especially, as comparative security for the lives of men, as well as the more selfish advantages of insuring the comparative security of the ordnance, and the most efficient working of the battery are obviously directly at stake, which might be forfeited by a too careful economy of pecuniary expenditure, in connexion with the constructive details now under consideration. Let them, therefore, be erected in rear of the ordnance they are to supply, in all positions (unless absolutely impossible), and provide for them the requisite artificial cover where demanded, whatever the additional expense may be, which, indeed, could be no very great amount, in comparison with the advantage otherwise gained. A mound of earth between them, and the point of danger is all that would be required.

Sometimes the position of an open coast battery may be so favourable, owing to the difficulty of the approaches to it from seaward and the features of the ground around, that a safe spot protected by natural cover may be found immediately in the rear, affording a suitable sight for them. Here of course is their true position. In a minor coast battery closed at the gorge, mounting but a small number of pieces, the gorge itself is their natural and best position. One of a larger description generally partakes more of the nature of a fort; and consequently the same remarks, under this head, apply to it as those already made in reference to a fort in the foregoing.

See Plan. With respect to the mutual relative position of these constructions, it is most desirable that they should adjoin one another; 1, 2, 3 and 4 should communicate interiorly under the same roof; and 5 and 6 might be provided in another, but adjoining building, if found more convenient.

The advantage to be gained by adopting the principle of grouping together all these constructions, belonging to each battery, are these:—It would enable their contents to be prepared and issued for action with the greatest possible celerity and safety; greatly simplify the service; and demand, comparatively, but few men to be engaged in the duty. It would also much facilitate the general daily supervision and care of the ammunition and stores; and there would be but one point for the gunners of the battery to resort to for the supply of their wants—a matter of great moment,—instead of, as at present in so many instances, their having to run backwards and

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forwards in as various directions as there are magazines and stores, causing thereby both confusion and delay.

Each battery and group of guns should bear a number conspicuously placed in it; and a corresponding number, with an inscription denoting its object, to be as easily distinguished, should be set up over the group of buildings from which the guns are to draw their supplies. This is mentioned because it is very necessary that it should be attended to; and the writer has never seen it carried out in practice anywhere. The metal-lined cases now in use make excellent portable magazines; and if their utility be properly taken advantage of, they will render the service of ordnance in batteries much more rapid, convenient, and secure than before their introduction. A receptacle large enough to receive one of these cases, with its opening upwards, should be made in the *terre-plein*, on the left of each piece in battery, well under cover of the parapet, and clear of the platform, and also so as not to interfere with free access to the shell recess (if there be one) in the parapet above it. This receptacle should be lined with brick or stone, and a stone cover, with an iron ring in it for a handle, provided for it, to close its mouth when the guns are not in action. This arrangement would furnish small intermediate magazines, conveniently placed, between the expense magazine and the guns; expose Nos. 7 to less danger than they would now be in, by their having to recur between each round to the expense magazine; and would do away with the necessity for one class of small store, viz. the cartridge case.[1]

See *a*, *a*, *a*, Fig. 1 of Plate.

In towers and casemated batteries of two or more tiers, a method of supplying the upper tiers of guns with ammunition from the stores below, might easily be devised, in order to avoid having to send men down for it. A few small iron cranes[2] on each tier, each with a single block for a "whip tackle," communicating with the magazines and store-rooms below, would fully answer every purpose demanded on this point; for by such means ammunition and stores, as required, might be hauled up with facility and expedition in their own boxes and cases. Thus any reasonable motive, which could be assigned, for constructing expense magazines in the batteries of even such works as these is removed.

3rd head,— *Form and dimensions.* See Pl. and description.

(3) *With respect to form and dimensions.*—These depend upon the position in which it is found necessary to place these constructions; the number of pieces to be served, and the amount of ammunition per piece to be stored.

It would be better if all were made bomb-proof; but it is absolutely necessary that 1, 2, 3 and 4 should be so, for the sake of security; as it must never be forgotten, when the question of expense, or any other

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[1] The way the writer proposes the metal-lined case should be used is as follows:—Nos. 8 and 10 of a gun preparing for action would bring up a case for the expense magazine, and place in the receptacle prepared for it on the left of the piece. No 7 would then stand by ready to serve cartridges to No. 8, when required, taking care carefully to close the opening of the case every time after withdrawing a cartridge. As each case became exhausted of its contents it would be replaced by another, from the expense magazine, by the appointed numbers.

[2] Similar to a boat davit on board ship, and made, like it, to turn inwards or outwards, in a socket, at will.

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difficulty is being raised as an objection, that men will work with greater will and effect in such localities, when under a sense of security from danger, than when they know that the roof over their head is permeable by shot and shell. Moreover, as the object of a battery is to produce the greatest effect in the speediest manner upon an opponent, every means, of which that under consideration is obviously one, should be provided, that can be obtained, to effect the purpose.

The nature of the position in which they are to be erected, and the space afforded by it, will direct the choice of form in designing these constructions; as no one design would answer under all circumstances of position. What has been stated under the 2nd heading must, however, never be lost sight of in arranging their plan.

The dimensions of 1, 2 and 3 must be such as will furnish sufficient stowage room for their proposed contents,[1] and admit of ready access to them when required. The size of 4 must be such as to afford room for its necessary fittings; for the men who would be employed in it preparing shells; and for those coming for and departing with prepared shells for the battery. The dimensions of 5 and 6 must be determined by the size and number of the articles they are intended to shelter, ample extra space being also allowed, in order that those articles may be readily got at when required. One sufficiently roomy store, adjoining 1, 2, 3 and 4, and appropriately fitted up, is all that is requisite.[2]

4th head,—*Interior fittings.*

(4) *With respect to interior fittings.*—In discussing this head of the subject, each of the details under consideration will be considered separately, in succession.

Fittings of the expense magazine. See *A*, Fig. 2, of Plate; and the description of the latter.

(1) *The expense magazine.*—As the ammunition within the expense magazine of a battery would of course be all made up, and packed in the ordinary metal-lined cases,[3] the usual frame-work dividing the magazine into bays would not be required. All that is absolutely needed is either an ordinary strong wooden floor, or else one composed of stout wooden balks, placed at intervals of a few inches, to keep the lower tier of cases from the ground,

[1] The amount of ammunition that should be provided in the expense magazines and store-rooms of a battery, beforehand, must of course depend upon the circumstances of the latter's position; that is, upon its importance, the probable duration of an action in which it might be engaged, and its distance from its principal magazines and stores. The number of rounds per gun, it is conceived, would vary from fifty (more than an hour's sharp firing), to two hundred, and even more.*

[2] Drawings are given at the end of this paper shewing the writer's ideas as to the best design for these constructions; and as illustrative of his views on other particulars referred to by him.

[3] "Or barrels, with an opening at one end," adds the officer before mentioned. But the writer objects, *in toto*, to barrels being used for the purpose. He has seen them of every description; common, metal lined, copper tinned, &c. used in magazines; and where the latter or the climate has been at all damp the powder has suffered in them, notwithstanding that every careful precaution had been taken to prevent it. He has seen cartridges taken out of barrels stored under such circumstances, which would have made far better missiles than missile-projectors. The metal-lined case, he believes, always answers.

* The same officer referred to in a former note remarks that "all magazine fitments should be mutiples of the dimensions of a metal-lined case scantling employed." The size of a metal-lined case including grummets, is given, by authority, as 1′ 5″ wide, 1′ 6″ deep, and 1′ 9″ high.—See *Drill Book*.

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which should be asphalted, or at least concreted, to repel damp. On this the cases would be piled tier above tier, the number of which should not exceed four, in order that the uppermost cases may not be beyond the convenient reach of a man standing on the ground. If the number of tiers exceeds four, a short ladder should be provided for the magazine, to facilitate operations within it.

The magazine should be well ventilated, and also be provided with the means of obtaining sufficient artificial light for it, when required.[1] This is not always attended to. Often the only means (when supplied at all), of lighting a magazine is through an opening covered interiorly with a perforated copper plate, and for which a miserable tallow dip is sometimes—but not always provided, when it is wished to inspect the magazine, supplying light just sufficient "to make darkness visible" within it, and of no service whatever to a person inside. What is required for this purpose is one opening, or more, according to the size of the magazine, made through one of its walls—the one most suitable being selected for the purpose—and for each of which should be provided a good oil lamp with a reflector, throwing its light into the room through a large bull's eye fixed on the interior side of the opening.

Fittings of an expense shell store. See *B*, Fig. 2 of plate, and the description of the latter.

(2) *The expense shell store.*—The following extracts from a memorandum dated, Royal Laboratory, Woolwich, 4th August, 1859, the most recent information issued on the subject of shells, may be acceptable, and will, in part, serve as useful data on which to base the consideration of the most appropriate fittings of an expense shell store.

EXTRACTS FROM A "MEMORANDUM RELATIVE TO PREPARING EMPTY, COMMON, AND DIAPHRAGM SHELLS FOR ISSUE FOR LAND SERVICE."

"*For Fortresses and Permanent Works.*"

1 "Common shells issued loose to have the rivet-holes and fuze-holes bees-waxed, and the metal plugs screwed in. The bottoms, rivets, wads, and spare plugs to be issued separately, in the proper proportion, viz. bottoms 110 per cent., rivets 110 per cent., wads 105 per cent., and the spare plugs 10 per cent., packed as directed for 50, 100, and 500 shells.[2]

2 "Common shells issued with bottoms fixed, are to have the fuze-holes beeswaxed, and a wood plug covered with serge placed in them. 105 per cent. of wads and plugs to be issued separately, packed as directed for 50, 100, and 500 shells.[2]

3 "Diaphragm shells to be prepared the same as for field service," viz. with the metal plugs screwed into the fuze-holes and loading-holes, the latter hole being oiled with Rangoon oil, the bottoms also fixed on; "the proper

[1] "I once found a broken barrel in a *dark* magazine, and took up a handful of loose powder off the floor," adds the officer before referred to. Such a dangerous circumstance could not have arisen had the magazine been properly lighted, so as to admit of careful periodical examination of the barrels.

[2] Plugs, rivets, wads, &c., will be specially packed for any number of shells not corresponding to 50, 100, and 500, on the requisition of the powder magazine storekeeper.

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proportion of gutta-percha wads and spare plugs to be issued packed for 50, 100, and 500 shells,[1] viz. 105 per cent. of gutta-percha wads, and 5 per cent. of spare plugs, for fuze-hole and loading-hole."

All diaphragm shells, whether for field or garrison service are issued and stored *boxed*. A small proportion, not yet fully determined on, of common shells for permanent batteries, and issued as described in paragraph 2 of the above extract, are also to be issued and stored *boxed;* the remainder, as described in paragraph 1, are issued and kept *unboxed*, and are intended to be piled outside the shell-filling room until required to be filled and finally prepared for use.

The wooden bottoms which are not fixed to the shells are issued strung upon iron rods (20 on each rod), with a nut at the end to retain them. Each rod is about 2 ft. 9 in. in length.

It would, no doubt, be far better were all shells issued with their bottoms fixed on and boxed; but this, probably, has been decided against on account of the additional expense it would entail. Also, it is most undesirable that the unbottomed and unboxed common shells should be piled in the *open*, and thus be exposed to depredators; as there is not the slightest doubt that as soon as the practice has become general on our batteries, and the light-fingered public have discovered the value of the metal plugs in the shells, there will be constant complaints from master gunners and others of some of them having been stolen.[2]

However, accepting as needs be the decisions above stated, which have been arrived at by the constituted authorities, and guided by them, the interior fittings of a shell store, as it appears to the writer they should be arranged, will now be described; and in so doing, in order to be more easily understood, he will propose a room of a determined size, and then describe its fittings:—

Suppose the room belongs to a group or battery of twelve 8-inch guns, provided with the following proportion of shell ammunition, viz.

50 common shells, and 10 diaphragm shells, per piece,	}	or	{ 600 common shells, and { 120 diaphragm shells, in all.

Of the above, the 120 diaphragm shells, being boxed, would require space in the shell store; and probably about 36 of the common shells also, which, in fact, is the proportion of boxed common shells, for twelve 8-in. guns, not long ago sent to Southsea Castle, Portsmouth. Further, space would be required for 620 wooden bottoms and rivets for the unboxed common shells; and also for the gutta-percha wads and spare plugs, which, however, would occupy but a very small fraction of the total space required. Finally, a store of fuzes corresponding with the number of shells (common and diaphragm), and the full proportion of friction tubes for the whole of the ammunition provided for the battery, would be kept in the shell-room, and for which accommodation must therein be provided. These last, packed as

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[1] See note 2, opposite page.

[2] The metal trucks belonging to an 8-in. howitzer carriage, mounted on a traversing platform, were stolen one night, not long ago, at Portsmouth, under the very eye of a sentry on his post. The trucks were removed without any noise sufficient to attract the sentry's attention, who was but a few yards off, and without the thieves going to the trouble of dismounting the howitzer.

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they now are, very compactly, in metal cylinders, would also occupy but a very small space.

A room equal to contain the ammunition and stores above detailed would be of the following dimensions:—8 ft. high, 9 ft. 6 in. wide, and 12 ft. 4 in. long, and should be thus interiorly arranged,—

The floor (if not boarded) should be asphalted or concreted; made, in fact, *perfectly dry*. On this seven wooden balks, 8 ft. 4 in. long, and 4 in. square, should be arranged, six inches apart, in the direction of the length of the room, leaving a clear space, of about 2 ft. in width, all round the walls, for a passage. In arranging the ammunition and stores, 3 ft. 4 in. of the length of the balks would be occupied by the boxes of diaphragm shells, piled five tiers high, on a base of six boxes by four; 1 ft. 8 in. of the balks would be occupied by the boxes of common shells, piled in three tiers, on a base of six boxes by two; and the remaining length of the balks would be occupied by the bars of wooden bottoms, piled across them, like shot, on a base of ten bars.

Around the walls of the room, and at 6 ft. from the ground, shelves, 8 in. wide, and 2 in. thick, should be put up, to receive the boxes of fuzes, tubes, spare plugs, and gutta-percha wads, and completing all the necessary fittings of the room.

Fittings of the grape and case store. See *D*, Fig. 2, of Plate, and the description.

(3) *The expense grape and case store.*—As it is very essential that *dissimilar* ammunition should be kept apart, in order to avoid mistakes in issuing it in the confusion of the hurry of action, a separate room for grape and case has been proposed. The end of a passage in the building in which the details under consideration are grouped, walled off for the purpose, would answer very well. No other fittings for such a room would be required than a floor prepared as described for the two preceding details.

Fittings of the room for filling shells and fixing fuzes. See *C*, Fig. 2 of Plate, and the description.

(4) *The room for filling shells and fixing fuzes.*—As opinions vary as to the necessity or otherwise for such a room as this, it may be as well to state them, for and against it, before describing the fittings of the room.

Objecting opinions.—Shells should be prepared at their guns; an indispensable necessity when a battery is in action against a moving object, and the fuzes would have to be bored at the last moment. Moreover, as shells have always to be prepared in the *open*, in rear of the guns, when engaged in the field, there can be no possible necessity for pursuing a contrary system with garrison and other permanent batteries.

Opinions in favor.—Notwithstanding the necessity for boring and fixing fuzes at the guns when their fire is being directed against a moving object, shells, if possible, should always be filled under cover before being brought up to the battery; as it is a dangerous operation to be performed under fire. Secondly, batteries bearing landwards would generally be engaged against stationary objects; and when the range of a stationary object, to be cannonaded, had once been determined, there could be no absolute necessity for boring and fixing fuzes at the guns; but, on the contrary, it is far better

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that they should not be so, in order to avoid all risk of accidental explosions on the battery in the operation. Before opening fire a stock of shells should be fully prepared; and a further supply could be easily maintained, if demanded, direct from the room in question, as rapidly as could possibly be required, thanks to the present pattern of shells and fuzes. The writer considers that a room of this description is very necessary for a battery.

It may be further stated that whenever Armstrong's rifled guns are introduced on our batteries, there will be no necessity whatever for preparing fuzes at the guns; as, by an admirable contrivance, the fuzes of his shells, after being fixed in them, can be set for the required range at the moment of loading. All previous preparation may, therefore, be made away from the battery, and under cover. A shell preparing room will, therefore, always be an advantageous and necessary addition to battery arrangements.

And now with reference to the fittings of the room:—

In order that the process of preparing shells may be carried on with every possible facility and celerity, the fittings of the room should be as follows:—At about six feet, or six feet and a half, up a convenient wall,—say running lengthwise, of the room, a wooden shelf, one foot broad by one inch and a half thick, should be fixed. On this shelf every small store required for preparing shells for the battery should be conveniently arranged and habitually kept, ready for immediate service. A few boxes of fuzes, of each nature, might likewise here be kept, always ready at hand for use.

At four feet six inches from the ground, and below the first shelf, another, eight inches wide by one inch thick, should be put up. The use of this shelf would be for the more convenient arrangement of a small stock of bursters and fuzes in front of each man employed in preparing shells.

Below the second shelf, and three feet from the ground, a table, two feet wide, and three inches thick, should be set up *very* strongly, for the men to rest the shells on whilst filling them and driving fuzes.

The space beneath the table could be appropriated when required during action, for stowing away cases of bursters and boxes of shell as they were successively brought in from the magazine and shell-store for use; and, indeed, it would be well if a few boxes of shells were always kept there ready for filling, immediately, when required. The room should have a boarded floor; be built very dry, and well lighted, by day and night. The walls should be not less than eight feet high.

Fittings of the room for small stores and side-arms and for the shot furnace. See *B*, Fig. 6 of Plate.

5 and 6.—*Shelter for the small stores and side-arms, and also for the movable shot furnace.*—In describing the fittings of a room intended for this purpose, it will be more simple and as well to propose a room of suitable dimensions, and then to describe its fittings. Assuming that the room is required for a battery of twelve 32-pr. iron guns of 56 cwt. mounted on dwarf traversing platforms, its dimensions should be 21 feet long, 12 feet wide, and 8½ feet high in the walls. It should be fitted up as follows:—

Six feet and a half from the floor, on both side walls of the room, six stout wooden or iron brackets, projecting two feet six inches from the walls, should be firmly put up, and so as to divide the length of each wall into

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seven equal intervals, for the purpose of receiving the sponges, rammers, and wadhooks; six sets arranged on each side of the room. Two feet below the above another row of brackets (similar in dimensions and number) should be put up, to receive the truck levers and handspikes, iron shod and common. At the extremity of each bracket of the second row, and also half-way between it and the wall, a hook should be fixed, for the purpose of suspending the water buckets and cartridge cases; one of each kind from each bracket. About three feet from the floor, below and in the mid-intervals of the second row of brackets, the same number of brackets as in each of the two former rows, and about one foot long, should be fixed to the walls, on which to hang the coils of tackles and preventer ropes for the guns; a pair of tackles, ready rove, and a preventive rope on each bracket.

By the above arrangement (designed after actual measurement) it would be possible always to keep together the side-arms, tackles, &c., required for each gun, affording thereby the greatest facility of issue when required.

One end of the room would be partly taken up by the door and window; the former should not be less than three feet six inches wide, and the latter should be large enough to admit plenty of light into the room. On the portion of this end of the room, unoccupied by the door and window, and also on the opposite wall, shelves, about one foot six inches wide and two inches thick should be fixed up; one shelf at six feet and another at four feet and a half from the floor, on which to arrange the elevating screws, spare sponge and rammer heads, tube boxes or pockets, and other small stores. The walls below the lower shelves should be boarded, for the convenience of fixing nails and brass hooks, for hanging up such articles amongst the small stores as may be desired. The floor of the room should be strongly boarded or asphalted, or at all events means should be taken to render it as firm and dry as possible. In one corner of the room a small drop table should be set up, to facilitate the operation of cleaning the small stores, when occasion demanded. The space within the walls not occupied as above described, would serve for the portable shot furnace and its appurtenances, the wads, wad tubes, and such other stores as it may be found convenient to place there.

Other rooms of this description of smaller capacity, required for fewer pieces of ordnance, should be fitted up on the same principle as that above described; or, at all events, on one equally systematic and convenient, its object being to bring, as much as possible, all the stores together, in sets, which would be required for each separate piece in the battery, thereby greatly facilitating their issue and distribution, when required.

Shell recesses. See *c*, *c*, *c*, Fig. 1 of Pl.

For the sake of convenience the 7th of the preceding details, enumerated at p. 281, has not hitherto been taken into consideration. It will now be so.

Their position and utility.

A shell recess for each gun and howitzer, made in the parapet on the left of the piece, has been provided in many existing batteries, where they would be found of great utility in time of need, under all circumstances. As, for instance, when a battery thus provided had to direct a fire of shells against a moving object, a stock of them, after being filled in the shell-filling room, might be placed in each shell recess previous to action, to be withdrawn as required, one by one, to be

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fitted with their fuzes at the gun; and to facilitate this latter operation, a narrow bench, about one foot wide and three inches thick, should be strongly fixed to the door of each recess, at about three feet from the ground;—this is wanting to the doors of existing recesses. Another convenient addition would be, a small box about one foot long by six inches wide and deep, with a hinged cover, placed on the door, a foot above the bench, to contain and protect the implements for boring and fixing fuzes when the guns were not immediately in action or not firing shells. Shell recesses would also be found very useful in a battery firing shell against a stationary object, as they would afford convenient and safe places to stow away for each gun a stock of shells, previously fully prepared for action, after the range had been determined.[1]

Their dimensions.

As regards their dimensions they should each be large enough to contain about fifty shells, sufficient to maintain a fire of about an hour's duration. The great objection to shell recesses is, that they necessarily weaken the parapet, and they therefore should not be made needlessly capacious. Their exact dimensions will of course depend upon the calibre of the ordnance of the battery they are constructed in.[2]

Fittings.

No other fittings are required for shell recesses than doors, and those already proposed above.

Mortar batteries.

Thus far the consideration of the leading subject of this paper has been solely with reference to gun and howitzer batteries. Mortar batteries have yet to be considered. A few lines will dispose of them.[3]

The requirements of mortar batteries, of the nature which have been under discussion in the preceding pages are few, and appear to be as follows:—

1. Expense magazines.

2. Expense store-rooms for small projectiles, such as pound shot and $4\frac{2}{3}$-inch shells, for volley firing, and for light balls.

3. Rooms for weighing out mortar charges.

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[1] The new edition of the Drill Book for heavy ordnance, implies in its directions for loading with shells, that they are, of every nature inclusive, to be lifted to the muzzle of the piece *in* their boxes. This is not necessary for any nature lower than the 8-inch, and this portion of the drill instructions would, consequently, never be carried out in actual practice.

[2] The following should be the dimensions of shell recesses, each to contain 45 shells, for 10-inch, 8-inch, and 32-pr. shells:

For 10-inch shells, 5′ 10″ high × 3′ wide × 3′ deep, in the clear.
„ 8 „ „ 5′ 6″ „ × 2′ 6″ „ × 2′ 6″ „ „
„ 32-pr „ 4′ 2″ „ × 2′ 6″ „ × 2′ 6″ „ „

[3] Mortar batteries are frequently seen in positions on coasts where it is evident they are intended to be directed against shipping. Whatever might have been their utility for this purpose in former days, before the introduction of steam as a motive power in ships of war, they are now in such positions entirely thrown away. No naval commander knowing his duty, and possessing the power of moving where and as he pleased, under steam, would expose himself to danger from a fire of mortars. Even mortar vessels, anchored to bombard a place, by hauling on or off, as the fire from shore became dangerously accurate, might evade all chance of being hit by mortar shells from the defensive works.

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4. Recesses for filling shells and fixing fuzes, on the battery.

5. Rooms to shelter the side-arms and small stores.

Each of the above details will now be considered separately, under the same heads as were similar details for gun and howitzer batteries, but with greater brevity.

Expense Magazines. Number, position, form, and dimensions.

Number .....
Position .....
Form and dimensions

(1) *Expense magazines.*—What has been written with respect to gun and howitzer batteries, equally applies here.

Interior fittings.

Interior fittings.—Loose powder for mortar charges being issued and stored in barrels, the fittings of these magazines should be a frame work on which to stack the barrels, similar to that provided for large principal magazines. The other arrangements should be similar to those described for the expense magazine of a gun and howitzer battery.

The bursting charges for the shells should always be prepared before hand, and packed in metal-lined cases, ready for use. Accommodation would therefore be required for the latter in the magazine.

Expense store rooms for small projectiles. Number, position, form, and dimensions, and interior fittings.

(2) *Expense store-rooms for small projectiles, &c.*—There should be one for each battery; but the end of a passage walled off and prepared as suggested for a grape and case store for gun and howitzer batteries is all that is necessary, as but a small stock of the projectiles for which it is required would be kept at a time in a battery.

Rooms for weighing out mortar charges Number, position, form and dimensions, and interior fittings.

Number .....
Position .....
Form and dimensions
Interior fittings .....

(3) *Rooms for weighing out mortar charges.*—What has been written with respect to fuze fixing and shell filling rooms for gun and howitzer batteries, equally applies here.

In addition to the fittings suggested, a room of this kind would require an iron rod, about three-eighths of an inch in diameter, with a crook at the lower end, fixed in the roof over the table, for each pair of scales provided for weighing out charges. It should reach to about two feet and a half of the table, and be otherwise so placed as to allow the scales to hang freely from the crook. At least one pair of scales should be provided for every four mortars; one for every three, would be more suitable.

There should be also additional shelves placed round the room to receive the proportion of fuzes and friction tubes supplied for the battery.

Though the principal object of this room is to enable the mortar charges to be weighed out with safety; yet every article required for preparing shells for the mortars should be habitually kept in it, methodically arranged, ready for instant service.

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Recesses for filling shells and fixing fuzes. Number, position, form, and dimensions, and interior fittings.

(4) *Recesses for filling shells and fixing fuzes.*—13 and 10-in. shells being so heavy and, consequently, laborious to move, would always be piled near the mortars, and therefore the whole process of preparing them for use would have to be carried on in the vicinity of the latter; and in order to afford the men so employed some adequate shelter, a deep recess should be constructed in the tail of every traverse (of which there should be one to every two mortars, at least), large enough to receive a small table, about the size and solidity of the old pattern fuze-bench, at which to prepare the fuzes; and to allow about half-a-dozen men to circulate tolerably freely in, whilst engaged in preparing shells or in carrying them to the mortars. These recesses should be bomb-proof; be provided with splinter-proof doors, with loopholes in them, to admit light, and in number should be one for every two mortars.

It is conceived that such a provision for a mortar battery as above suggested would be found very useful, and that it is not more than is absolutely required.

They would require no other fittings than those above mentioned; and when required for use, the necessary ammunition and stores would be carried in to them as successively called for.

8-in. mortar shells being comparatively light and manageable, should be entirely prepared for their mortars in the room for weighing out mortar charges. No recesses in the traverses would therefore be required for a battery of this calibre. The shells should be piled outside the room above mentioned.

Rooms to shelter the small stores and side-arms. Number, position, form, and dimensions, and interior fittings.

(5) *Rooms to shelter the small stores and side-arms.*—What *Number* ..... *Position* ..... *Form and dimensions* *Interior fittings* ..... has been written with respect to gun and howitzer batteries, equally applies here, except that it will be necessary to bear in mind that brackets would only be required for sponges and common handspikes, and that no space is necessary to be provided for shot furnaces or any of their appurtenances.

Minor useful details for batteries.

Besides the details of batteries already considered, in the foregoing, there are a few other arrangements of secondary importance which, although not absolutely necessary, it is very desirable should be provided, viz.:—

Epaulment for the shot furnace. See *CC*, Fig. 1 of Plate.

1. An epaulment thrown up in a convenient position to protect the moveable shot furnace when in use, in cases where the work itself does not furnish sufficiently convenient and perfect shelter.

Small water tank. See *ddd*, Fig. 1 of Plate.

2. A small receptacle about two feet cube, made in the *terre-plein* on the right of each gun, to serve as a water tank for No. 2, and as a substitute for the ordinary water bucket, and thereby doing away with the necessity of providing so many of the latter as are now required for a battery.

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Sheds for guns, &c. &c.

3. Sheds, suitably fitted up, to protect from the weather sling carts, platform wagons, gyns, tackles, and other stores required for transporting and mounting or dismounting ordnance, placed at convenient intervals along the line of batteries, in extensive works. In minor works, one would be sufficient. In casemated works and towers they would not, probably, be required; as from the nature of such works shelter for this purpose could be obtained within them, without necessitating the construction of special cover.

Some who read this paper, accustomed to the mean and altogether inadequate accommodation hitherto furnished for the service of our batteries, may be inclined to doubt, and others also to ridicule the idea of the necessity for much of what has been herein demanded for them. Still, nevertheless, the writer is fully persuaded, from his observation at most of our fortified stations on both sides of the Atlantic, and from much consideration on the subject of permanent batteries, under the various circumstances in which they may be placed, that with less than what he asks for them (a very moderate demand) they cannot be considered efficient, more especially in positions where they would be called upon to repel attacks made by shipping.

Were not the long-suffering patience, almost amounting to indifference, of the artillery officer, so well known, and which keeps him silent even when he has legitimate cause to complain, it would seem strange indeed how such inadequate provision and arrangements, as those which our batteries now comprise, could have been so long quietly accepted without proper representation and remonstrance, by the members of that corps most concerned in the matter; whose success and, consequently, credit would have been much jeoparded had any of those batteries been engaged with a sufficiently powerful and skilful opponent; and until the remedy required is furnished their success and credit must still remain, in this direction, in a very perilous position.

Millions have been already spent upon our fortifications and the ordnance and equipments of our batteries, combined, and yet to remain most imperfect, as a means of defence, after all; and the country is about, we hear, to expend ten millions more after a similar fashion. It is therefore earnestly to be hoped that some one, in a position to do so with effect, will bring the question which has formed the subject of this paper to the notice of the authorities concerned; with a view to prevent such mistakes, as those which have been herein commented upon, being repeated in our new defences, and to have those existing in old ones remedied.

Besides the points which have formed the subject of remark in the foregoing pages, there are other defects, innumerable, existing in our batteries,—defects of design and construction, patent to the whole corps of artillery, to which it is to be hoped some member of that corps will call the attention of the authorities before it be too late.

Note.—At page 279 the writer has complained of the defective system in practice in our army in determining certain details of defensive works.

It is always easier to find fault than to suggest a remedy; yet the writer

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thinks it may be as well (it certainly can do no harm) to attempt to shew how the difficulty may be met in this case, as follows:—

Hitherto (whatever may be the orders on the subject, the writer does not pretend to say), it has been the practice in preparing projects for batteries in defensive works, for the commanding engineer to submit his plans to the consideration of the officer commanding the artillery, solely with a view to the determination of the armament; the nature merely, not the number, of the ordnance. The details which have been considered in the foregoing pages, and others which equally concern the artillery, are never entered into or discussed seriously between them. These are left entirely to the engineers; to those who project, and to those who approve of the work; the projectors often being—and by the candid of the corps, confessedly so—very uninformed on the subject; and they have in consequence to be guided partly by their own reading and ideas, and partly by a certain circular, dated some years back, which cannot be, to say the least, a sufficient guide under all circumstances of position and detail, into the latter of which the writer believes it does not enter very minutely. Moreover, we have made such rapid strides within the last few years, in matters connected with artillery, that the circular in question must on many points be obsolete.

Having pointed out what the present system is, as practised, and the defects of it, the proposed remedy will now be stated:—

Let a Board be assembled by authority, composed of three or five artillery and engineer officers, experienced and practical men; the president to be an artillery officer, and the members to be in equal proportions of the two corps. Let their instructions be to enter into all artillery questions connected with defensive works. Let them be directed to consider and determine upon the arrangements most suitable, even in the most minute details, as regards construction, armament and provisionment of batteries, under every probable circumstances; and to draw up a work on the subject, to serve as a practical guide for both corps. Let this work be then submitted for the consideration of the Commander-in-Chief, and any portions of it disapproved of by him, should be referred back again to the Board for their reconsideration and alteration, if necessary. And, finally, when the work has been approved of by the Commander-in-Chief, let it be printed and published as a manual for those concerned. As of course it is rarely possible, and on this subject quite impossible, dogmatically to lay down rules which would serve under all circumstances, commanding officers of artillery and engineers should be allowed a certain latitude, as regards their instructions, in projecting defensive works, it being however an understood rule that they are not to deviate unnecessarily from them. Thus, with a common guide to direct them, when a new work had to be projected, the commanding engineer would draw up his plans of it, as at present. He would then submit them to the commanding officer of artillery to decide upon the armament, and the details connected with the latter, pointing out to him at the same time the object of the work. A few subsequent personal interviews, in which the subject should be fully discussed between them, would finally arrange every detail; and the responsibility of defects thereafter observed in the arrangements determined upon, before or after construction, would fall upon the corps concerned, greatly to the comfort of the engineer, no doubt, who would not always be, as at present, vilified for every mal-

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arrangement discovered; as the artilleryman would have to bear his share of the burden of reproach for defects to which he had been a party in creating.

As the British service is quite deficient of an authorized professional work on the subject of combined operations between artillery and engineers in garrison and in the field, the instructions of the board, above proposed to be assembled, might be extended to directing them to draw up a more comprehensive work than that already suggested. The latter might be made to include, not only what has been proposed, but also full instructions for both corps on the attack and defence of works of all kinds; and concerning all operations in which they would have to combine, together with such other matter as may be deemed necessary. That a work of this description is much needed, the experiences of the ordnance corps, both in peace and war fully demonstrate.

M. O. NIXON,
Lieut.-Colonel, Royal Artillery.

Portsmouth, Dec., 1859.

Description of Fig. 2 of adjoining plate, being a design for an Expense Magazine, an Expense Shell Store, a Fuze-fixing Room, and a Grape and Case Store-room, for a battery of twelve 8-inch guns of 65 cwt.

A. THE EXPENSE MAGAZINE.—For 1200 rounds (100 per piece), 10 lbs. charges, of which 120 for diaphragm shell, and the remainder for common shells, hollow shot, &c. This ammunition would require 125 whole metal-lined cases, of which 14 would contain 600 2¼ lbs. bursters for common shells, and 1120 60 drs. bursters for diaphragm shells. The cases to be piled four high within the rectangular space shewn by the dotted lines in the figure, leaving a clear space between them and the walls for ventilation and as a passage.

B. THE EXPENSE SHELL STORE.—For 120 diaphragm shells and 36 common shells in boxes, 620 wooden bottoms, and the other stores, arranged as described at page 288. The dotted rectangular figure shews the space within which the boxes of shell and the wooden bottoms should be piled, leaving a clear space within the walls for ventilation and for a passage.

C. ROOM FOR FILLING SHELLS AND FIXING FUZES.—Eight men to be employed at the table filling shells and fixing fuzes; four men in bringing empty shells from shell room, bursters from magazine, fixing bottoms to shells, and in issuing prepared shells to men sent for them from the battery. Two feet linear are allowed at the table for each man employed at it. The remaining space within the room is allowed for the other men who would be employed in preparing shells, and for those coming for them from the battery.

D. THE GRAPE AND CASE EXPENSE STORE.—For 120 rounds (10 per piece), piled in boxes three deep, three wide, and seven high.

G and *G'*. WINDOWS 6′ × 4′ to light fuze-fixing room. One window is sufficient for the purpose, and may be placed at *G* or *G'* according as safety and convenience demands.

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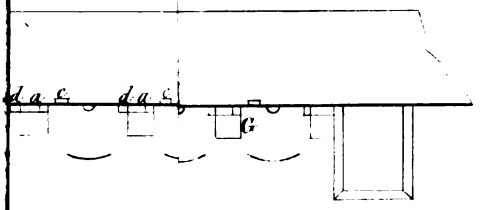
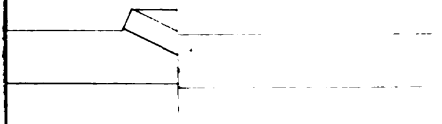
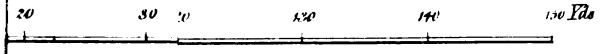
Plan of a re, &c.

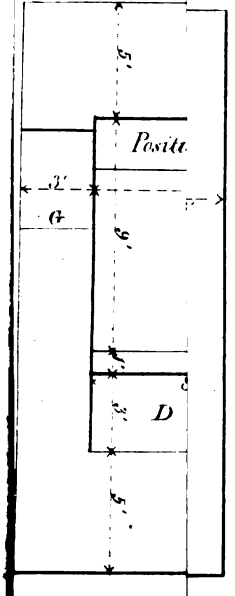


A to R = about 70 yds.
re, however, only 8 yds.



& Case Store, & Fuze
Shot Furnaces.
R. Receptacles for Metal lined Cases.
Small Tanks, for use of Nos 2.
Shell Recesses.





For a Mortar Battery, the arrangement of the building would differ so far from the adjoining figure, that it would contain no Shell Store (B) and the Magazine (A) would be calculated and arranged to contain powder barrels instead of Metal lined Cases only.

Lithographed at the Royal Artillery Institution

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a, a. APERTURES AND BULL'S-EYES, for artificial light to the magazine.

d. APERTURE AND BULL'S-EYE, for artificial light to fuze-fixing room.

E. APERTURE 2′ square to give light to, and ventilate the shell-room.

The building is intended to be made bomb-proof, the walls being not less than nine feet to the spring of the arch, which is intended to run in the direction of the length of the building.

There are more doors and passages than are absolutely necessary; yet they would be found of great convenience in avoiding crowding in actual work.

The thickness given for the walls, are those assumed to be the most appropriate, but that is a builder's question.

Fortification in an Artilleristical[1] *point of view: a new system adapted to existing arms.* By Lieut. Alexander DOULL, R.A.

[Read January 11, 1860].

THERE is no military question of the present day of greater importance than this: "What alterations in the systems of defence will the introduction of rifled ordnance occasion?" England for the first time finds her natural barriers removed by the advances of science,—she must arm and fortify. It becomes therefore, imperative upon us, members of one of the scientific corps of the army, to investigate carefully the new conditions, which the alterations in the arms in use will impose upon us, in carrying out these requirements.

During the performance of my duties as district adjutant at Sheerness, the subject of fortification has been forcibly brought under my notice. The re-armament of the whole of the existing forts having been undertaken, and their effect upon the defence of the Thames and Medway and of the intermediate and surrounding ground having been a subject of frequent consideration.

Starting from the principle, enunciated by Montalembert and made the basis of the systems of Carnot, Choumara, Wittich, Fergusson, and others, that a successful defence can only be made when full development is given to the fire of artillery; I have arrived at conclusions, both as regards the trace and the profile most fitted to carry out this principle, so different from those hitherto laid down, that I feel a strong desire to submit my views to the same ordeal of public professional criticism to which others have submitted theirs. Hence the present paper.

A first law of fortification is: "That the practical application of its general principles depends entirely upon the arms in use." To apply these arms properly is the chief part of an artilleryman's duty; to get the greatest effect

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[1] This word, first used by Lieutenant Maxwell in his translation of Taubert's "*Tactics of Field Artillery*," appears to me to be as unobjectionable in form as it is necessary to convey a distinct idea, which can only be otherwise expressed by a circumlocution.

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from them with the least possible exposure in return is the object of the leading features of a fortress; the determination of their relative position and command, their trace and relief, is therefore a very important artillery question.

There is no need to prove that existing systems are defective. They were devised before Enfield rifles and Armstrong guns, and this fact alone is enough to prove their unfitness for present times. It is impossible that systems designed to meet the imperfections of "Brown Bess" and smooth-bore guns should afford opportunity for developing the full power of the arms now in use.

To return to first principles,—to analyze the natures of fire and the conditions under which they produce most effect,—to suit the trace to these conditions, and to combine this with that profile which is least liable to injury; this is the object I have proposed to myself. I have not entered into the question of the expense of my system compared with that of others. All estimates of pattern forts are in every respect so problematical that no sound information respecting any system can be obtained from such an investigation. Nor do I consider this a main feature of the question. It may be an object in determining whether a fortress shall be built at all, or whether another mode of spending the money it would cost would not be more efficacious; but, once determined that a fortification is absolutely necessary, and there cannot be a greater mistake than to permit any saving of expense by which its efficiency is one whit impaired. No comparison can be made between an imperfect and a more perfect system on the ground of expense. The absurdity of the attempt of Fourcroy to make the possible duration of a siege, and the expense of the construction of a fort, units of measurement of its value has been so ably and so frequently exposed, that it is only necessary with respect to it, to refer those, who have still a latent belief in its use as a touchstone of the merit of systems of fortification, to Choumara's able refutation.

Having determined the correct principles upon which a fort is to be built and the nature of its trace and profile; by what mode that fort can be most cheaply executed, is an important engineering question, and for that reason one into which I have refrained from entering.

I have not considered the application of counter-mines to the defence, being of opinion that, to any system having a ditch of the necessary depth, a system of counter-mines can be applied, and that its efficiency depends in no way upon the peculiar conditions which influence the trace and profile. I have but very casually considered the question of casemates, for the protection either of guns or troops, they are an advantage nearly equally applicable to any system. My object is to establish certain laws of trace and profile as necessitated by existing arms, considering the matter in an artilleristical point of view.

There are two elements in every fort, the aggressive and the purely defensive. The artillery part of the defensive element of fortification is the flanking fire. The conditions of a flanking fire are, that it should be retained efficient to the last moment, it must therefore not be seen from a distance; that it should be at right angles, or as nearly so as possible, to the works it flanks; that it should in no way impede their fire, and that it should see the bottom of the ditch throughout its entire length. These conditions are

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only fulfilled by casemated *kaponiers*[1] in the ditch. The mode in which I propose to obviate the defects of these works pointed out in the project of attack on the German system by Mons. le Capitaine Mangin will be shewn in treating of the application of this system to detached forts.

The aggressive elements of fortification are artillery fire and sorties: of the former there are three classes, each of which has been made the leading feature of some existing or proposed system of fortification. First, vertical fire, the main feature of Carnot's propositions; secondly, direct fire, the leading characteristic of the polygonal systems; and thirdly, cross fire, the principal element in the bastioned and tenailled systems.

Vertical fire is almost independent either of trace or of profile. The only defence against it is casemates, and these may be applied as readily to one system as to another; they may necessitate certain modifications of relative command, but can in no way alter the leading principles which determine the trace and profile. The only condition which vertical fire imposes upon the trace or profile is the avoidance of such constructions either in the general features or in the details as are peculiarly liable to injury from this species of fire; such for instance as tiers of batteries on the slope of a hill, parallel long lines of batteries at short distances from one another, or, in detail, exposed masonry communications, imperfectly protected magazines, &c.

The importance of direct fire increases with every improvement in the range and accuracy of the arms in use, and no trace is in any way suited to existing conditions which does not give full scope to this feature of the aggressive element. On it depends that an assailant shall be compelled to open his trenches at a distance; to have his stores and camp beyond the extreme range of the artillery of the fort, and that his progress from such extreme range to the edge of the counterscarp shall be conducted under cover. The conditions of a parapet which shall give the greatest development to direct fire are, considerable command, that it shall see into all the ground within range, a direct bearing upon the surrounding country, and the power of concentrating a considerable amount of fire upon any point within range.

Direct fire not requiring that the parapet should be broken in any manner, the only traces which it is necessary to investigate are the circular and the polygonal. I believe that the circular trace possesses no advantage over the polygonal, but that the latter has the superiority in that, first, it is more easily flanked; secondly, the flanking defences are better defended; thirdly, it is less liable to enfilade; fourthly, it possesses greater adaptability to ground; and fifthly, it has greater power of concentration.

To prove these points:—

First, a straight lined system is more readily flanked than a circular, because the fire of artillery, proceeding in straight lines, the flanking battery being at right angles to a straight line to be flanked, *every* gun in that battery

[1] This word is used in accordance with a suggestion in the Woolwich Papers on *Fortification*, in order that two classes of works as distinct in design and purpose as the *kaponiers* of the German systems, and the *caponnieres* of the modern French system, may be distinguished as well in name as they are in the objects they are intended to fulfil.

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can be concentrated at *every* point in the line to be flanked; this is not the case in the circular trace.[1] It is true that the principle enunciated by Choumara, of the independence of the scarps and ramparts, a principle, the value of which cannot be too highly estimated, reduces the application of this fact to the question of the trace of the ditches, for it is quite possible to have a polygonal ditch surrounding a circular fort; but, on the other hand, the more nearly the trace of these two parts correspond, the less will be the loss of ground and the expense.

Secondly, taking the ordinary view, which is true at short ranges, that a polygon has greater concentration opposite the side and less opposite the salient than the circumscribed circle, then if the flanking battery be placed opposite the centre of the side of the polygon, in order to reduce it, which is necessary to pass the ditch, a lodgment must be formed opposite that portion of the side of the polygon where the greatest concentration of fire is possible, a concentration greater than that of the circumscribed circle.

Thirdly, the circular trace is equally accessible to enfilade in every point. Take a circle of 520 yards radius, equal to an octagon of 400 yards side, such as that laid down in Mr Fergusson's *Essay*, page 46,[2] a versed sine of 10 ft., which is the least distance of the breech of a gun from the parapet when run back, gives a chord of 200 ft. Hence, from every point without such a fort there are two lines of this extent exposed to enfilade. In the contained octagon, it is only on the prolongations of the faces that enfilading batteries can be established; hence, in adapting a polygon to the ground, the possibility of throwing these prolongations upon such ground as it is difficult to erect batteries upon, or from its low position it would be difficult to obtain the correct line, or where the greatest concentration of fire could be brought to bear. No such resources are available in the circular trace because every point without is a position for an enfilading battery.

Fourthly, a circular battery gives equal distribution of fire in every direction. The object desired is, not to have an equal amount of fire upon every portion of ground, but, so to proportion the amount of fire to the difficulties of ground that the total available defensive power shall be everywhere equalized. In the polygonal trace by lengthening or shortening the faces, increasing or decreasing the salient angles, every variety of concentration can be obtained and so proportioned to the facilities of approach that the total defensive power shall be the greatest possible upon every point. Equal facilities are not afforded by the circular trace.

Fifthly, to investigate the comparative powers of concentration of the circular and polygonal traces.

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[1] See, on this subject, Choumara's criticism on the curved faces and flanks of the bastions in Bousmard's system, a criticism which by anticipation applies equally well to the flanking arrangements in Mr Fergusson's system.

[2] As Mr Fergusson is, or rather has been, the great advocate of curved forms for batteries, my conclusions in reference to the trace of the parapet best suited for direct fire, are necessarily directly opposed to his, but, I am far from differing with him in principle. It will be seen, indeed, that what I endeavour to shew is that a practical solution can be given to the problem;—How, in a given prepared field of battle, to procure, a superiority of fire over the assailant. Neither Montalembert's exposed masonry forts or Mr Fergusson's circular shell traps, have yet satisfactorily solved this point.

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All concentration of fire depends upon obliquity of fire, and the degree of obliquity must be determined before the concentration can be ascertained. I have taken the opening of an embrasure at 30°, and I have assumed that an embrasure in which one side is perpendicular to the parapet is the most oblique admissable. An embrasure is the movable element in permanent fortification; it can be readily changed according to the position of the attack. If these assumptions be admitted, the obliquity of fire is 30° from the perpendicular.

Concentration of fire is not required equally at all ranges; it is most necessary where the greatest accuracy is possible. At long ranges slow and deliberate fire is necessary to obtain the maximum result with the minimum expenditure of ammunition. This is not the position where the greatest concentration is wanted; it is required at the longest range at which very great accuracy is attainable; thus the advantages are accumulated in such a manner that the greatest result is obtained from artillery fire.

Neither is it necessary (apart from peculiarities of ground) that the concentration shall be everywhere equal. If a parapet be such that 15 guns can be concentrated upon any point in front of it, and if 15 guns are not sufficient to stop an advancing sap, but 20 are; and if I can so modify the trace as to bring 20 guns to bear upon certain points, although I thereby reduce the fire upon others to 10, I stop that advance; for, if approaches are made at the intermediate places, their communications with one another are intercepted, and each separate attack detached, and thereby so weakened that any considerable development would be impossible.

In accordance with these principles, it will be easy to shew that at every range a greater concentration of fire can be brought to bear upon some points in front from a polygonal than can be from the corresponding circular parapet, and also that, at a given range, which shall be determined according to the nature of the arms in use, as that, where the greatest concentration of fire is necessary, a polygon can be found from which a greater concentration shall be obtained upon every point in front than can be from the circumscribed circle.

Let *AB* (Fig. 1) be the radius of a circle which it is intended to fortify, *BC* the distance at which the greatest concentration of fire is required, then 30° from the perpendicular on each side being the admitted obliquity of fire, if *D* and *E* be points on the circle such that *ADC*, *AEC* be each equal to 150°, all the guns from *D* to *E* can be concentrated on the point *C* and no gun not included between *D* and *E* can be so concentrated. What is true of one portion of the circumference of a circle being equally true of all points, the arc *OCP* described from the centre *A* with the radius *AC* represents the line of concentration of that number of guns which can be mounted between the points *D* and *E*. Let *BF*, *BG* be perpendicular to *AD*, *AE*, intersecting them in *K* and *H* and meeting the circle in *F* and *G*. Then the number of guns which can be mounted on *BF* or *BG* will be equal to the number which can be mounted on *HBK* or on the arc *DE*. Draw *HL*, *KL* parallel to *DC*, *EC*. By construction the point *L* falls within *C* and is the point at which all the guns from *H* to *K* can be concentrated. Draw *BN*, *GM* parallel to *HL*, *FN*, *BM* parallel to *KL*, then it could readily be demonstrated that *NM* is a straight line perpendicular to *AC* passing through *L* and that it is the locus of intersection of lines parallel to *HL*, *KL*, measured

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at equal distances along *BF, BG*; let these equal distances be the distance from one gun to another, then *MN* is a straight line such that at any point in it, the same number of guns can be concentrated from the polygon *GBF* as can be concentrated from the circle *GEBDF* at the arc *OCP*. At the points *M* and *N* the whole of the guns in one side of the polygon can be concentrated. Make *GBR, FBQ* each equal to 60°. Then the fire of one side of the polygon can be concentrated at the points *Q* and *R* respectively, and upon all the ground without the lines *QN, RM*. Hence, the polygon attains a concentration over the ground included between the lines *RM, MN, NQ* and the arc *OCP* which is not attainable from the circular trace within the arc *OPC*.

Let r = radius to be fortified.

C = distance at which greatest concentration is required.

P = angle of polygon.

60° = greatest admissable obliquity of fire; then

$$\left(\frac{r}{C} + 1\right) \tan 60° = \tan \frac{P}{2}$$

is a formula expressing the relation between the radius to be fortified, the distance at which the greatest concentration is required, and the angle of the polygon.[1]

To show the adaptation of this principle. If it were desirable to construct a fort with a radius of 250 yards whose greatest concentration of fire is required at 500 yards distant, an octagon whose sides would be about

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[1] When this paper was read, an officer of the Royal Engineers present stated that he believed a somewhat similar demonstration of this point had been already published. I have searched for it, but have not been able to find it. An incidental confirmation of the views advanced in this paper is afforded in the evidence of Captain B. T. Sullivan, R.N., C.B., before the Royal Commission on the National Defences (p. 11).

* * * * "In every fort whether casemated or earthen, one rule should be followed; each face should be straight, and two faces should never make a smaller angle than would permit their guns to cross their fire.

120. CHAIRMAN.—At what distance, 100 yards or so?—You could not cross close alongside. But supposing vessels are a few hundred yards off, the two faces of a work would be so short a space that if they could throw their shot parallel or slightly inclined, even at 500 yards or 1000 yards, they might meet. A vessel anywhere in front of the angle of a fort should not be able to be at a weak point; the guns on both these faces should strike her.

121. Mr FERGUSSON.—Would you not avoid that by having circular batteries?—It is because I believe circular batteries are so defective in that respect that I speak of this. I am surprised to find how few guns in a circular fort can be concentrated on one point, and how many weak points there are in some of these circular and oval forts; whereas if you put them in faces in that way, so that on every point you have a whole face, and off every angle two faces bearing on any spot, I think you will find that you can bring more guns to bear on a vessel at any given spot than you can from a round fort. I particularly allude to that, because I found that at one fort at Cronstadt, which ought to have been a principal one, if we had attacked it we could have placed eight floating batteries, and all the force of the squadron to back those floating batteries, gun boats and all, with only three guns in each tier which could have borne upon them, and four guns *en barbette* above, that is to say ten guns, which were all that could be opposed to the floating batteries and the gun boats and so on to attack them. The fort was oval; it had a long face with circular ends, and the circular ends were the weak points."

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190 yards would be the proper polygon. Suppose however that certain peculiarities of site require that the greatest concentration of fire shall take place at 1500 yards, a heptagon of 220 yards side would fulfil the required conditions. Take as another example the *enciente continué* of Paris which approximates in form to an ellipse of 3500 yards minor and 4500 yards major-axis. If the greatest concentration is required at the distance of the detached forts so as to prevent the enemy operating between them, and to restrict the development of his attack to the ground concealed from the enciente by the detached forts themselves, sides of 1200 to 1250 yards with angles of 160° would solve the problem required.

An inspection of Figure 2, which shews the respective concentrations of a duodecagon supposed to be able to mount 100 guns per side and of the circumscribed circle, will establish the superiority of the polygon as regards the second condition of concentration. The dark lines on one side shew the concentration of the circle, and on the other that of the polygon. The concentration is measured at every 50 guns. It will be seen from an inspection of the diagram, that at short ranges, the circle has the advantage opposite the salient and the polygon opposite the side, at that range at which the whole of the guns of one side of the polygon can be concentrated, the polygon has the advantage all the way round, very markedly so opposite the side, and that at ranges beyond this the circle has a slight advantage opposite the side, but the polygon has a very great advantage over the salient. If the units of measurement be the length of the side of the polygon and the number of guns that can be mounted on that side, then the comparison between the two will be,

Guns.	By the polygon can be concentrated at	By the circle at
·5	·3 opposite side ... ·75 opposite salient...	·55
1	·75 opposite side..... 1·5 opposite salient...	1·75
1½	not opposite side 2·25 opposite salient...	5·25
2	not opposite side 3·00 opposite salient...	not at all.

In cases where a continued enciente is combined with detached forts the advantage of the polygonal trace is much increased, for by regulating the lengths of the sides in such a manner that the salient angles shall be exactly in rear of the detatched forts, and arranging the distance between the two so that the detached forts shall be placed with reference to the enciente in the position marked *A* (Fig. 2). Then the superior concentration of the polygon at short ranges opposite the centre of the side is brought to bear in preventing the enemy penetrating between the detached forts, while the greater concentration at long ranges opposite the salient is brought to bear on the direct approaches to the detached forts, and the cross fire of two detached forts compensates for the deficiencies of the polygon at long ranges opposite the side. Thus, in the south side of the Paris defences, the ground from Charenton to Issy is occupied by six detached forts averaging 2000 yards apart and 1800 yards from the enciente. A duodecagon of 2000

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yards side would answer the conditions required, and bring the whole fire of one side (which might be 200 guns) to bear upon every point between the detached forts and of a side and a half (300 guns), allowing for the portion masked by the detached forts themselves, upon the direct approaches to these forts. The simplicity of such a trace would permit of a tram-way being laid down all round the city, so that all the long range ordnance upon the defences might be concentrated upon any point where siege operations were commenced, without in any way interfering with the security of the whole place from assault, which could be efficiently protected against by 28 kaponiers, at 1000 yards apart, each having six howitzers which mounted on recoil carriages and made breech loading would require only five men each, and the whole garrison necessary to secure Paris from assault would therefore be, allowing two reliefs and ten men for flanking the kaponier, 2800 men.

The advantages claimed for right-lined constructions over circular, are then, first, that the ditches or other material impediment to prevent assault must be in right lines, in order to be the more readily flanked; secondly, that parapets disposed in right lines afford facilities for adaptation to ground and for security from enfilade much greater than that possessed by circular parapets; thirdly, that advantage may be taken of the variable concentration of polygonal forts to place the works intended for flanking defence in such positions that the enemy in order to attack them must make a lodgment where the fire from the polygonal trace is greatest; fourthly, that the available concentration, of a right lined fort, upon all the ground within range, is (provided that the angle of the polygon added to the angle of opening of the guns upon the work be sensibly greater than 180°) very much greater than that of a circular fort and, further, that the nature of this concentration gives great facilities in the case of the combination of a continued enciente with detached forts.

I propose to add the next offensive element, the concentrated cross fire upon the enemy's near approach by means of tenailled lines of low command, the re-entering angles of which shall be 120°, and the salient angles as large as possible. As within the range of greatest concentration of the fort, determined as above, the amount of direct fire decreases much more rapidly towards the salient than towards the centre of the side, branches of the tenailled line (which would be armed with howitzers and musketry) are directed in such a manner that a large amount of fire shall be concentrated at the edge of the counterscarp at the salient angle, the branches from which this fire proceeds are the short branches of the lines and could not be readily enfiladed, and it will, in treating of the profile, be shewn how it is proposed to protect these lines from attack until the assailant arrives within such distance as to come within their concentrated power.

A parapet of polygonal trace for direct fire; tenailled lines with re-entering angles of 120° and very flat salients, so disposed that their greatest concentration shall be at those points where the assailant's lodgments must be made, and where the fire of the inner line is least effective, for the cross fire upon the nearer approaches; the ditches flanked by casemated kaponiers; these are, in trace, the main features of the system I recommend; they are exemplified in the drawing illustrative of the continued enceinte.

To consider the profile.

The inner parapet must have considerable command to ensure the whole

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surrounding ground being seen into and to enable it to co-operate with the tenailled line. Of course the increased effect of rifled ordnance requires a thicker parapet. The rule by which the thickness of parapets is ordinarily determined, viz. as one half greater than the penetration of the most powerful projectile which can be brought against it, appears to be founded on no sufficient reason. I would substitute this rule,—That the projectile most destructive to earthen parapets being shells, and the effect of a shell being measured by its greatest penetration *plus* the radius of rupture produced by the explosion of the charge which it contains; the parapet shall be so thick that, allowance being made for the increased penetration consequent upon the earth being disturbed by previous explosions, no tendency shall be exerted by the exploding shell to overthrow the merlon; this would give 25 ft. of parapet to resist a 10-in. shell and 40 ft. to resist the most powerful rifled ordnance. The penetration being 15 ft., the radius of rupture of an 8 lb. charge 10 ft. 8-in. and one half additional being allowed for the increased effect upon thoroughly disintegrated earth.

I propose to increase the exterior slope considerably. The natural slope of loose earth is from 1¼ to 1½ to 1. If therefore the exterior slope of a parapet be 1 to 1, the effect of a shell exploding in that parapet is not confined to the earth removed by the explosion, but the surrounding portions being loosened, the exterior slope on each side of the crater has a tendency to assume a slope greater than that at which it is constructed, and to this extent the thickness of the parapet is diminished and the parapet weakened. One of the chief advantages of an earthen parapet is its repairability. If the rampart be constructed with an exterior slope steeper than the natural slope of loose earth, the earth when minutely divided by explosions cannot be made to assume this slope, and hence the parapet cannot be reconstructed of its original height without occupying a base greater than the original one which is generally impossible. The effect also of such shells as penetrate only so far that their explosion will produce a crater, depends mainly upon the nature of the exterior slope. Thus, if a shell falling at an angle of 10° to the horizon penetrate 5 ft. into a parapet, if that parapet has a slope of 1 in 1, the line of least resistance will be 4 ft. The crater formed by the explosion of a 5 lb. charge,[1] allowing ¼th increased effect for the more complete combustion of the charge owing to the resistance of the shell, will be a two-lined crater. The displaced earth will be 117 cubic feet, and the amount of earth which falls in, supposing the earth above the crater to stand at ½ to 1, will be 80 ft., making a total displacement of 197 cubic

[1] It is to be regretted that there are no satisfactory recorded experiments, determining the effect of different charges of shells when acting as mines. The only experiments that I am aware of are those recorded in the 10th paper of the new series of the *Professional Papers* of the Royal Engineers for 1855. They are too few and not sufficiently systematic to furnish data upon which to base formula for general use. The experiments were with one 13-in. shell charged with 11½ lbs. of powder, buried 4′ 6″, the effect was equal to a charge of 39 lbs.; one 10-in. shell buried 2 ft. 6 in. with a 4 lbs. charge which produced an effect equal to a 7 lbs. charge; and six 10-in. shells buried 4 ft. 6 in. deep with 7 lbs. charges, three of which produced the effects of 14 lb. charges, one of an 18 lbs. charge, and two only of a 6 lbs. charge, though this latter small effect seems to have been due to the position of the shells just under the exterior crest, the lines of least resistance in these cases being only 3 ft. 6 in. It is remarked that the resistance to the explosion of a buried shell being greater than that of a shell which buries itself, the effect of the explosion will also be greater.

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feet. In a parapet with a slope of 2 to 1, under the same conditions, the line of least resistance will be 3 ft., the radius of the crater 3 ft. 4 in., the contents 62 ft., and the earth which falls in 11 ft., making a total displacement of 73 ft. In a parapet with a slope of 3 to 1 the line of least resistance will be 2 ft. 4 in., the radius of the crater 3 ft. 8 in., the contents 57 ft., which will be the total displacement as the upper surface of the crater is already at a slope of ½ to 1. The relative effects of a 10-in. shell upon slopes of 1 to 1, 2 to 1, and 3 to 1 are then, 197, 73 and 57 cubic feet of earth displaced in each slope when the shot penetrates 5 ft. falling at an angle of 10°.

For these reasons then I would reject all slopes less than 2 to 1 and would make use of a slope of 3 to 1, or even of a flatter one wherever space can be obtained for it. The first profile is taken across the continued enceinte, close to the kaponiers, and has an exterior slope of 3 to 1. In the three lower profiles a modification of this slope is shewn which possesses great facilities for repair. The general slope is 3 to 1, and at every 10 ft. in height this is cut into steps of 10 ft. horizontal and a slope of 2 to 1. The level portions would intercept the fall of the earth, afford earth for repairs, and enable the reconstruction of the whole parapet to proceed at once. In the ordinary parapet if the slope be of any length, whatever earth may be available for repairs at the berm, the labour of reconstruction is immense from the difficulty of conveying earth from the berm to the top of the slope where it is most required. A slope of the nature shewn in these profiles would be as easily repaired as if it were only 10 ft. high. In the ditches the counterscarp is higher than the escarp, in order that the enemy not being able to injure it from a distance[1] may be compelled to form a lodgment on the crest of the counterscarp and that even when this lodgment is made, it shall be as difficult as possible to effect a breach. To do this in the profiles given requires a depression of 25°. The berm and lower part of the parapet protected by the additional height of the counterscarp afford means of repairing the upper parts of the parapet and of preparing such repairs even when the parapet above is being destroyed.

The command of the tenailled works is low, not to interfere with the fire of the main parapet, to combine a grazing fire with the plunging fire of the latter, and to be more easily secured against fire from a distance. In the first profile each parapet is covered by a ditch, so as to necessitate a lodgment being made on the second parapet under the plunging fire of the upper works; a second descent into the ditch, the reduction of a second kaponier, and the breaching of an additional escarp. In the

[1] No experiments that I am aware of have been made to determine the possibility of breaching ordinary revetments by other than direct fire. The experiments carried on against the Carnot Wall shew that by a great expenditure of ammunition a detached wall may be breached by pitching fire; but while on the one hand many writers express an opinion that the effect upon an ordinary revetment would have been the same, Sir H. Douglas at whose recommendation the experiments were undertaken, and most of the writers of the modern French school attribute the effect to the oscillation produced in an unsupported wall by the impact of the shot. The only fact bearing upon this point that I can find is that at the siege of the citadel of Alessandria by the Austrians in 1799, the face of a bastion was breached by the shot used to enfilade the ravelin it supported; but there is no information either as to the quality of the masonry, the construction of the revetment, the number of shot fired, or the proportion which it was estimated took effect upon the bastion.

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second profile the inner ditch is discarded, and Carnot's detached wall is shewn; it is sunk so far below the crest of the counterscarp that shot fired with the same elevation as those in the Woolwich experiments would not strike the top of the wall. In the third profile a very broad wet ditch is substituted for the revetment; and in the fourth the counterscarp is unrevetted, but the escarp has the ordinary revetment. The top of the kaponier is never raised above the edge of the counterscarp. Whether a kaponier of one or two stories is necessary depends, I conceive, upon whether the ditch which it flanks is beyond the effective range of grape or not. The object of the kaponier is to bring such a heavy fire upon an assailant attempting an assault, as shall ensure the failure of his attack; if the whole of the wall be within the effective range of grape, three howitzers of large bore, which for facility of working should be mounted on recoil carriages and made breech loading, would, throwing alternately canister and grape, increasing the proportion of the former or latter, according as the main attack is within or over 300 yds., bring such an amount of fire to bear as would prevent any attack succeeding. Thus a kaponier of one story high with three howitzers on each side would be sufficient to flank 1000 yds. of ditch, which might be either in one straight line or in two, the kaponier being placed at the angle. Should it be considered necessary to have a more powerful battery, because of the length of the ditch to be flanked, or for other reasons, then the kaponier would be constructed as in Plate 2, the upper guns throwing shrapnel, to ranges beyond 400 yds., and flanking not only the wall, but also the berm and the lower portion of the parapet. In the case of a detached wall, *à la Carnot*, a kaponier of this construction would flank the descent of the counterscarp, the ascent and descent of the wall and the subsequent ascent of the parapet. The detached wall applied and flanked in this way is the most efficient protection against assault possible, and would be the cheapest that could be constructed in case where a wet ditch is not available. The power of the kaponier to resist or to keep under the fire of a counter-battery at the salient of the ditch is a point to which I attach little or no value. If the enemy can succeed in establishing an earthern battery against a masonry kaponier no practical amount of artillery fire will prevent its destruction; a day or two's delay may be the result of a very heavy armament in the upper tiers, but this is the outside that can be expected for a very great expenditure of money and men.

I propose to cover the tenailled lines by a double glacis, the crest of which shall be of equal height or nearly so with the crest of the lines, and distant about 200 yds. The outer slope of the glacis is determined by the distance and command of the inner parapet. The edge of the counterscarp to be placed so that the fire of the guns shall, passing as close over the tenailled lines as is practicable, strike within a few feet of the edge, thus giving the greatest possible slope to the inner glacis.[1] The objects attained by this double glacis are that all the works intended for the near defence are unseen, and therefore unattackable until the enemy reaches the crest of this glacis;

[1] It will be readily seen that this inner glacis, though countersloping, has no single point in common with the *glacis à contrepente* of Carnot.

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the flanking and cross fires are thus preserved intact until the moment they are required. This desirable object has never yet been accomplished in any constructed work, nor has any feasible means of attaining it been suggested.

The enemy established on the crest of this glacis has before him this problem. To subdue the fire of lines of as great extent as his own which are untouched until his arrival within 200 yds. of them, and which are so constructed as to bring the greatest concentration of fire to bear upon the points where, to be least accessible to the direct fire of the inner parapets, he must first arrive. To do this he must make a lodgment in force upon its crest, and in so doing necessarily, to a great extent, mask the fire of his rear batteries employed in keeping down that of the inner parapet; opportunity is thus given to the defenders to re-construct and re-arm the inner parapet, and the problem before the besieger then becomes to subdue the fire of the double tier of batteries; to sap down hill under the plunging fire of a parapet with the command of 40 to 70 ft. at distances of 300 to 100 yds. with a concentrated cross grazing fire from a series of tenailled lines of equal relief to his own, and he must do this while the extent of ground on which he can construct his batteries is little more than half that of the batteries of the defence. I believe that to arrive at the top of the counterscarp is under such circumstances impossible. The double glacis further affords every facility for sorties. Sorties are seldom efficacious (Vauban said that he never knew one delay a well directed siege for half an hour), but the knowledge on the part of the besiegers that the work attacked is so constructed as to afford every facility for sorties in force, necessitates, if the garrison be enterprising, a careful, slow, and well regulated advance; the keeping of a large guard of the trenches who are under fire; hence, the casualties are much increased, and if the siege be attempted with any inadequacy of force the large guard reduces the strength of the working parties and materially increases the labour of the siege. Sorties could not be made with any prospect of success until the enemy arrives within 400 or 500 yds. of the body of the place. From this point until his arrival at the crest of the double glacis, the inner glacis affords an admirable space for massing troops in any number unknown to the enemy, and prepared even in daylight to take advantage of any opportunity discovered from the inner works. The crest of the glacis would of course during this period of the siege be occupied by the defenders' rifle pits. When the enemy reaches this crest, the ramps in the counterscarp afford nearly equal facilities for those small sorties which at this period of the siege are most efficacious.

The third profile shews an adaptation to a site where water is found close to the surface. Here, whatever be the advantage of the double glacis, it may be a question whether it would subject the besieger to greater disadvantages than the peculiarity of the site and the necessity of constructing all the batteries above the surface of the ground. Hence it is omitted, and the command of the inner parapet lessened. The fourth profile shews the adaptation of this trace to a feature of ground of frequent occurrence, when gradually sloping ground terminates in a flat top. In this case the ground forms a natural double glacis by withdrawing the inner parapet sufficiently back. At a slope of 1 in 20, this requires a parapet of 60 ft. to command the slope of the hill, and be sufficiently retired from the crest to give proper development to the fire of the tenailled lines.

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At flatter slopes less height would be required or greater range could be given to the fire of the tenailled lines.

To recapitulate very briefly the points I have successively dwelt upon. I have endeavoured to shew that of the two artillery elements of a successful defence, one, vertical fire can be neglected,[1] as requiring no special trace and no peculiarities of construction (casemates excepted) being of any use as a protection against it. The other element, horizontal fire, is of three classes; direct fire, upon which in proportion to the increase in the range and accuracy of artillery must the defence more and more depend; a cross fire upon the near approach of the enemy, and, a flanking fire to the parapets and ditches. These three natures of horizontal fire are so distinct as to require for their proper development three different parapets. I have endeavoured to prove that the direct fire requires a parapet of high command and polygonal trace; that a tenailled line of low relief so situated that the plunging fire from the inner parapet may be readily combined with it, and having a number of its least accessible branches concentrated upon the most approachable points, fulfils the conditions of a close cross fire, and that flanking fire should be from kaponiers in the ditch, which should be of one or two stories according to the length of ditch which they have to defend, but which should never appear above the crest of the counterscarp. The whole work to be covered by a double glacis, the crest of which to be of equal or nearly equal relief to the tenailled lines, screening them from the distant attacks of the enemy. The inner slope of the glacis to be as great as possible consistent with the proper combination of the fires of the two parapets. A great increase not only to the thickness of the parapet, but also to the base of the exterior slope by which the stability of the work is much increased, and the effect of shells upon it much diminished. A mode of dividing that slope into stages by which its repairability is greatly increased without diminishing its stability. A broad berm for the same reasons as a flat exterior slope, the top of the escarp to be so much below the crest of the counterscarp that a depression of 25° shall be necessary from a battery on the edge of the counterscarp to effect a practicable breach.

The advantages claimed for this construction generally, and for the double glacis[2] in particular are, that in addition to proper development being given to the direct fire of the work, and the cross fire being secured against attack until the moment it is required, the inner glacis affords great facilities for sorties and for the employment of field artillery and small mortars during the progress of the attack up the outer glacis, and that its crest is during the same time an admirable position for rifle pits; also, that a lodgment on

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[1] It must not be supposed from this that I wish to underrate the effect of vertical fire; on the contrary, all experience goes to shew that the effects of pierriers and small mortars during the latter portion of a siege, either in attack or defence cannot be overrated; what I desire to imply is that no special trace is necessary for the full development of this defensive element.

[2] It will be seen that in the construction of this double glacis, every facility is afforded for carrying out the suggestion of Merkes, that the ground over which the enemy's approaches must advance should be prepared by placing qantities of stones, &c. about 2 ft. below the surfaces, so as to render the construction of the trenches very difficult, and the effect of shot upon them when made very destructive.

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the crest of this glacis is necessary in order sufficiently to subdue the fire of the tenailled lines to be able to proceed with the attack; that such a lodgment impeding the fire of the distant batteries, employed against the inner parapet, gives time for the re-establishment of this latter if it shall have been much injured or even completely silenced; that the completing of this lodgment in the face of the fire of the tenailled lines is very difficult, and, when the advantages for re-establishing the inner parapet are considered, almost impossible; that, even if executed the enemy has to sap down hill under a plunging fire from one parapet and a grazing cross fire from another; in order to reduce the kaponier he must effect his lodgment on the edge of the counterscarp where the greatest amount of both direct and cross fire can be concentrated. These latter advances being rendered practically impossible by the fact that the only development possible to the attacking batteries at this stage is the crest of the glacis which is little more than half that possessed by the defenders, a considerable portion of whose batteries are up to this moment untouched.

I believe, I leave it for others to determine with what justice, that no existing or proposed system possesses equal advantages.

It remains only to shew the application of this system to detached forts. One of the great results of the increase in the range and accuracy of artillery fire is that the area of ground to be included within the works necessary to secure dockyards, &c. is so great that a defence by a continued enciente becomes impossible. No system would be applicable to the defence of such a position, and therefore to existing conditions if it did not possess peculiar advantages when applied to detached forts.

Respecting the trace of such forts it is evident that no rule can be laid down to meet the infinite variety of positions in which and purposes for which they are required; but it must be clear that a system which places no limit to the trace except that no salient angle shall be equal to or less than 120°, if it is to depend for its defence upon its own parapet, and which affords in the tenailled lines means of remedying any defects of direct fire which may arise from the necessity of using smaller angles, possesses at least the advantage of being readily adapted to all natures of ground. The tenailled lines are of course subordinate in utility and necessity to the parapet for direct fire; it is upon this that the action of the fort upon the surrounding ground depends, and in determining the direction of the faces of a fort, the only questions to consider are, in what directions is it necessary that this fort should fire, and what amount of fire in each direction equalizes the total defensive power which the resources at command authorize the employment of.

One example will however put this matter in a clearer light than a great deal of explanation. I have selected the eastern defences of Lyons. Of all the examples of recent fortification of which drawings are published, it is that which is most favorable for a comparison, because the ground possesses no marked features calling for great departures from the types of the system adopted. It is almost level, a small and clearly defined rise of between 30 and 40 ft. in the centre, being the only feature. The circuit defended is rather more than four miles in extent, and is occupied by four bastioned forts, three small forts, and two lunettes; a redoubt is proposed to close the left flank.

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The bastioned forts are:—

(1) Le fort de la Vitriolerie, which has two fronts of 220 mètres, and is closed by three polygonal faces of 150 mètres. This fort has a dry ditch 30 mètres wide, and a wet one of 80 mètres in advance of the glacis; a bomb proof barracks for 800 men, and the whole of the two bastioned fronts are casemated.

(2) Le fort de la Motte is on a quadrilateral, 3 sides of 200 mètres and one of 300, with advanced lunettes, and defensive casemated barrack.

(3) Le fort de Villerbanne on a pentagon, with 3 sides of 250, and 2 of 200 mètres, retrenched bastions, counterscarp galleries, casemated flanks, and defensive casemated barracks.

(4) Le fort des Brotteaux has 3 sides of 260 mètres and one of 400, this latter being flanked by a redan in the centre. In other respects similar to the others.

These four forts would require at the most moderate calculation garrisons of 1600, and le fort de Villerbanne of 2000 as peace garrisons. In case of actual siege it is not probable that more than one fort would be attacked which, including the faces of the collateral forts which would bear upon the attack, would require about 2400 men extra.

These forts are supported by two double redans, Fort Columbier and Fort de la Tête d'Or, flanked by works called stone bastionettes, but which resemble in every particular the kaponiers of the German systems. These two forts would require 400 men each.

Three lunettes,—la lunette des Hirondelles, le fort de la Part Dieu, and la lunette des Charpennes, complete the list of the executed works. They are all flanked by bastionettes, and the two latter have double ditches, the outer one being wet. They would require garrisons of 150, 250, and 200 men.

La redoubte du Haut Rhône is not yet commenced. From the importance of its position it cannot be a work for less than 500 men.

The defence rests therefore upon ten works requiring for ordinary garrison 7800 men, with an addition of 2400 in case of siege, making 10,200 men.

The upper part of Plate 2[1] shews these forts in their relative positions; the lower shews the application of forts constructed in accordance with the principles I have advocated, to the same site.

The works consist of six forts; the two flank ones having one face of 100 yards and four of 50 yards, the other forts have two faces of 100 yards each and four of 50 yards. The long faces would mount fifteen and the short seven guns each. The parapets for direct fire to be casemated à la Haxo, or with some other casemate of similar design. The faces towards the country have salients of 135 degrees, are covered by tenailled lines, and by a double glacis. The crest of the double glacis is in two lines, forming a salient, and directed upon the salients of the collateral forts formed by the two short branches, so that one of the faces may enfilade the inner and the other the outer glacis. The forts are connected by some material obstacle, in this instance a wet ditch; where this is not available a ditch 35 ft. deep

[1] This plate is taken and the description of the works abridged from the "Essai sur la Fortification moderne," par le Bn. P. Emile Maurice.

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meeting in a point with a step cut in the escarp about 12 ft. below the ground on the edge of which a detached wall would be built, such as that suggested by Captain Westmacott, R.E., in a paper in the *Professional Papers* of the Royal Engineers for 1855. The ditch connecting the forts forms a slightly re-entering angle, and the gorge of the fort is in the prolongations of these lines, and the defensive barrack to the fort being placed at the re-entering angle formed by these lines, flanks the ditch between the forts. Thus all passage between the detached forts would be interdicted to the assailants. Without this necessary precaution where circuits as large as those which now require to be defended,[1] are occupied by detached forts only, on their outer circumference, it would be possible for an enterprising enemy, to push in force at night between the forts, thereby cutting off supplies and facilitating landing on the flank of the lines (in the case of dockyard defenses). Behind this obstacle also a secure position is afforded for batteries to take the besiegers near approaches in flank, and on level ground, the forts, so connected, could be placed further apart than they otherwise could.

Such forts as those proposed for Lyons would require for their security against surprise, to man the kaponiers and the guns flanking the intermediate ditches 300 men, to furnish a guard for the glacis 100 men, to man ten guns of the inner work 100 men, total 500 men. The flank forts would require 100 men less having only one kaponier; total for the enciente of four miles 2800 men. To man the whole of the guns for direct fire in an attacked fort with the necessary reliefs would require 1200 men, or 1100 additional to the above garrison. To man the crest of the double glacis as a covered way, and subsequently the tenailled lines, providing for casualties, for working parties, and for the necessary reliefs would require 1500 men, or 1400 men more than the above garrison; total for attacked fort 2500 additional or 3000 men, and an equal number for those parts of the two collateral forts which would bear upon the attack. The total garrison in case of siege would therefore be 7800 men.

If this result be compared with the garrisons for the existing forts round Lyons, it will be seen that a saving of 5000 men is effected in the garrisons of the various forts until the trenches are actually opened against a particular fort, and that in time of siege a saving of 2500 men is effected.

If the defensive power of these forts be estimated, it will be seen that each fort brings to bear directly upon the ground over which an enemy must advance 30 well protected guns, and that each fort supports the collateral forts by a fire of 14 well covered guns. The assailant has therefore to silence by direct fire 58 guns before he can approach with any degree of safety. Arrived within 800 yards of the place, he may anticipate sorties not merely of the garrison of the attacked fort, but of any force which can be collected within the enciente, and which may be massed either in front or on either flank, well covered by the double glacis, the crest of which is within 500 yards of him, and crowned with rifle pits. If he succeeds in

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[1] "In cases where the nature of the country would admit of an enemy obtaining a full view of the dockyard within practicable range, which cannot now be estimated at less than 8000 yards, it is necessary to establish defences, so as to command the ground within that limit.—*Report of the Commissioners on National Defences.*

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safely advancing over this 500 yards, he has then to make a lodgment which will mask all his rear batteries in the face of the fire of the tenailled lines, and to sap down 150 yards, under this fire combined with that of the rear parapet. During the last 500 yards of approach, the collateral forts have a flanking fire over the whole ground, and the inner glacis in particular is commanded by the tenailled lines of these forts as well as by their rear parapets; the whole of the ground within the ditches connecting the forts is also available for the construction of earthern batteries to take the attack in flank. If the enemy notwithstanding this reaches the edge of the counter-scarp, he must subdue the kaponiers before the ditch can be passed. If the ditch is wet this cannot be done by mining, and the only position from which the kaponier[1] can be counter-battered, the other end of the ditch, is seen in reverse from the collateral forts and from the whole ground between the forts, besides being the point of concentration of the fire of four faces of the tenailled lines. Such a fort could with difficulty be taken even if the guns for direct fire be not protected from vertical fire, but if they be efficiently protected, there exists no known means by which they could be reduced. I know of no existing or proposed system which possesses such defensive power or which furnishes such a solution of the problem, how the few can be enabled successfully to resist the many.[2]

It is an admitted principle that all detached forts should be provided with bomb-proof cover. If this cover can be so designed as to protect at once both men and guns, then the fort is able to bring its whole defensive power to bear upon an assailant. Otherwise it is possible so to inundate a small fort with shells that parapets, guns, and men shall be destroyed without the defensive power of the fort being called into play. The only known case-mates suited for this purpose are Haxo casemates. Some similar ones have been proposed by Mons. le Capitain Merkes, but the lateral and vertical range of the gun is too restricted, and the interior space too small to admit

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[1] Since this paper has been sent to press, I have been informed that an arrangement of the flanking kaponiers similar to that shewn in the proposed forts at Lyons, has been carried out in some of the detached works now executed at Plymouth in accordance with the recommendations of the Commissioners on National Defences. It is only to be expected that, at a time when many minds are being turned to the same subject, many ideas should suggest themselves at the same time to different people. These works have the considerable command and increased thickness of parapet recommended; but the exterior slopes are not much greater than usual, and the principle regulating the angle of the polygon has not been applied.

[2] In the Report of the Commissioners on the National Defences which I have already quoted more than once in the notes, which has been published since the above paper was read, the principles on which works should be constructed were thus stated:—"The works should be so designed as to be defended by a small body of men against a *coup-de-main;* they should at the same time have capabilities of resistance that will enable them to withstand any attack likely to be brought against them. With this view they should be provided with redoubts at their gorge, by means of which an enemy would be prevented from holding the work if he should succeed in obtaining partial possession of it. The main ramparts should be capable of affording a heavy fire, in those directions over which an enemy must make his approach; and bomb-proof cover should be provided for the garrison. In situations where the ditches can be filled with water, no revetment need be constructed; but, wherever this is not the case, they should either have escarps and counterscarps or detached walls of masonry; and in either case they should be flanked both by artillery and musketry." In every one of these particulars the forts above proposed carry out the principles enunciated by the Commissioners.

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of their being used as barracks. Haxo casemates are much stronger in appearance than in reality. The amount of exposed brickwork over the embrasure is about 45 square feet, the exposed portion is the crown of the arch, where one shot would bring down the whole casemate. The protection afforded by the earth to the arch is more apparent than real, for the earth sloping upwards does not attain a thickness of 4 ft. 6 in. until 9 ft. from the face of the arch, and nowhere is the thickness greater than this. The modification of Haxo casemates proposed by Mr Fergusson would have been, had artillery remained as it was when that modification was designed, a great improvement, but it is still open to the objection of having the crown of the arch very imperfectly covered. The fall of one arch facilitates very much the fall of those near it, and the increased penetration of artillery has diminished greatly the resisting power of the three concentric rings. Plate No. 2 contains a plan, section, front and rear elevation of a casemate which has I believe some advantages over these. The exposed brickwork is not the arch of the casemate, and its fall does not necessarily involve the destruction of the casemate; the fall of one portion of the casemate in no way weakens the parts right and left of it; great facility is given for communication, &c.

The crown of the arch of the casemate is parallel to instead of perpendicular to the line of parapet; the gun fires out of the side of the main arch. To form the embrasure a small arch is run out of the principal one, having an arc of 90° of 10 ft. span, and 5 ft. high at the springing. That projection is given which will admit 60° of fire.

Not the least advantage possessed by this form of casemate is that suppose the embrasure to be destroyed, and the fall of earth from its top to have exposed the main arch; unless the destruction of that arch were instantly attempted, it would be possible to supply the place of the embrasure, and the retaining wall at its top by a mound of earth or a gabionnade, which would retain the necessary thickness of earth on the top of the arch, which would thus remain available as cover for troops, although the gun in it were temporarily silenced, and the reconstruction of the embrasure might proceed under cover of such a screen from the inside and the gun be ready to open fire in a little time. The amount of exposed brickwork is 30 ft., and with this, and the earth sloping backwards at 1 in 1 (as in the Haxo casemate) the least thickness of earth in any part of the arch is 4 ft. 6 in. If a retaining wall be added over the embrasure (as shewn in the Plate) the exposed masonry is increased to 50 ft.; but then the earth slopes backwards at 1½ to 1, and there is no where less than 6 ft. of earth covering the masonry. To give an equal amount of cover to the arch of a Haxo casemate it would be necessary to increase the exposed masonry 55 ft. making a total of 100 ft. Such a casemate would cost rather less than £150 a gun, and would give cover for about ten men besides the gun. The screen to cover the exposed masonry, if of iron 6 in. thick, would cost about £80.

In conclusion: I believe that every increase in the range, accuracy, and penetration of artillery favours the defence, because increased range necessitates the opening of the trenches at a greater distance, hence increased labour in the approaches, and as the stores and camp must be out of range, increased labour in bringing up materials and carrying on the reliefs, more especially when the attack is well advanced; increased penetration necessitates increased thickness in the attacking batteries and approaches,

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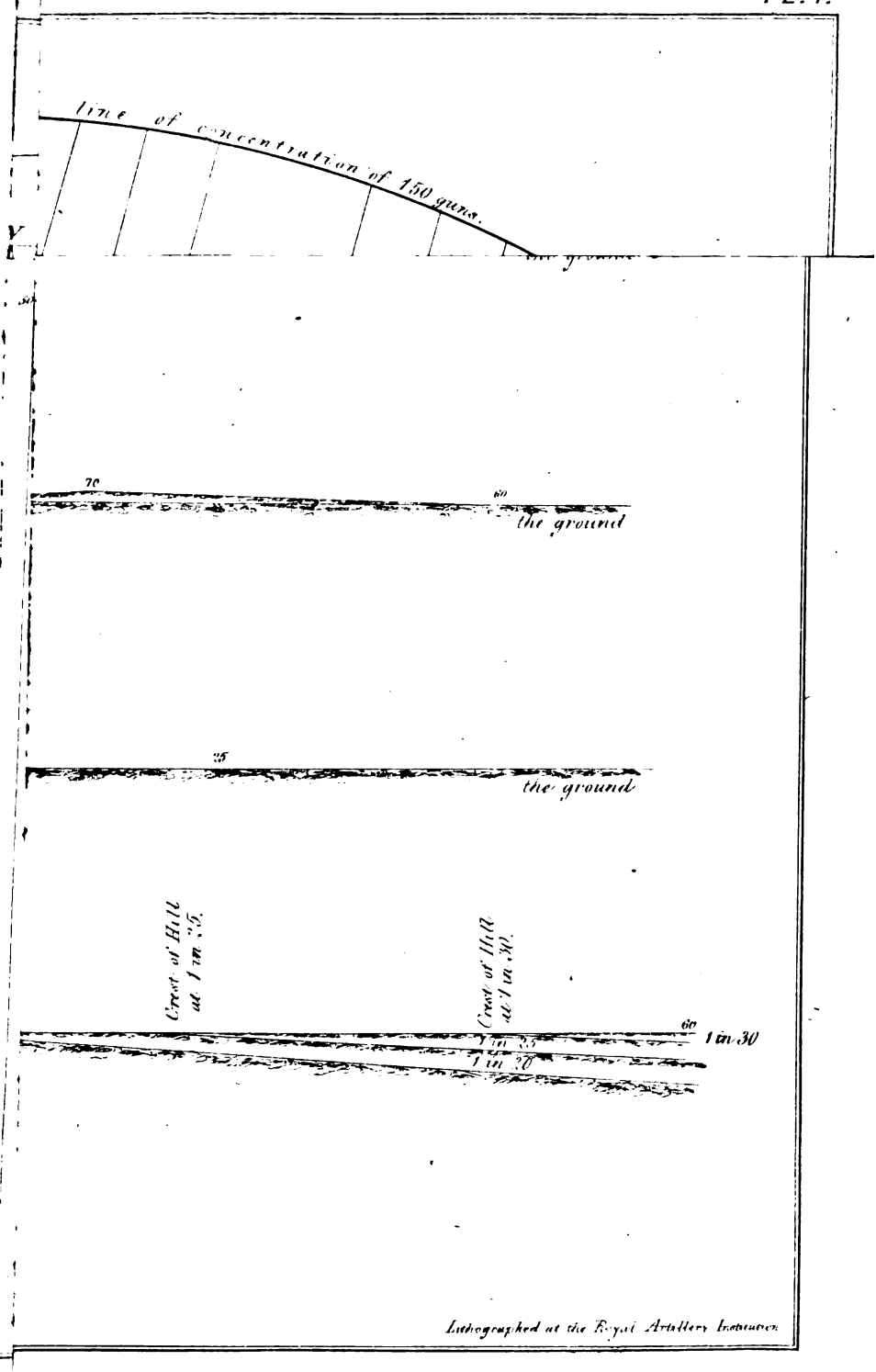

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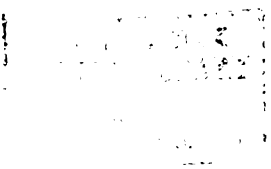

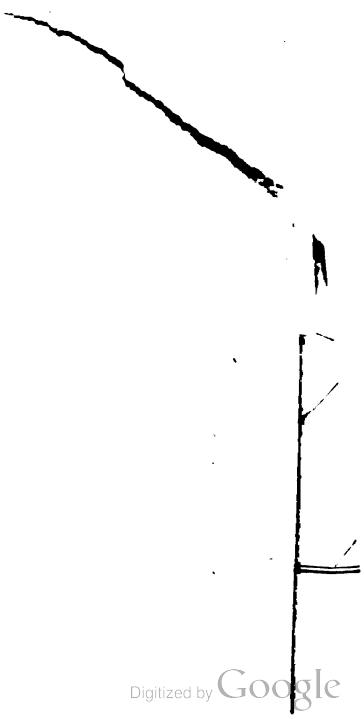

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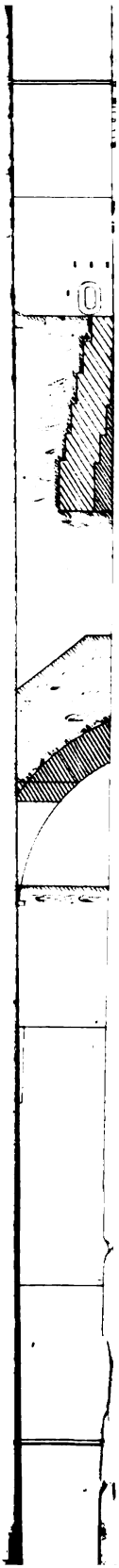

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hence also increased labour in the attack. These advantages are not secured to the defence in existing systems, because proper development is not given to direct fire, where cross fire is brought to bear upon the near approach, it is not preserved from attack until the time it is wanted, and the enemy is seldom under the necessity of advancing close to the foot of the fort, as it is nearly always possible if it were worth the expenditure of ammunition to destroy the flanking defences and the revetments from a distance, while the earthern ramparts are of that form which it is most easy to destroy and most difficult to repair. All these points have been examined in detail, and an endeavour has been made to point out how full force can be given to the artillery element in the defence.

The result of that investigation (as exemplified in the application of the system recommended to the protection of the east side of Lyons) has been to prove that, if proper development be given to the artillery fire of the defenders, and the material obstacles be of such a nature and so placed, as to be defended by a minimum of artillery fire, it is possible to protect efficiently any extent of ground with only 700 men per mile; and that an addition of 5000 men to the forts actually attacked by the regular process of a siege will enable such an enceinte to resist successfully any attack, however powerful that can be brought against it. If these statements be correct, then the attack is no longer superior to the defence, and it is possible for a few men to resist successfully any force that can be brought against them; and our dockyards and arsenals can be protected not merely from *coups-de-main*, but from all the effects of a well directed siege, by garrisons which will not materially influence our strength in the field. These are important facts, and it is with the view of ascertaining how far my attempted proof of them is correct that this paper is submitted to the consideration of those of my brother officers who have turned their attention to this subject.

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Annual Report and abstract of the Proceedings of a General Meeting of the Royal Artillery Institution, held on Wednesday, May 30, 1860.

MAJOR-GENERAL SIR R. DACRES, K.C.B., IN THE CHAIR.

THE Committee of the Royal Artillery Institution have the honor to submit to the Annual General Meeting their report for the year 1859-60, and call attention with great satisfaction, to the steadily increasing utility of the Institution, and to the furtherance of those objects to promote which it was originally founded.

The accompanying Table exhibits the increase and present state of the Institution with regard to numbers. The whole number of Members at the commencement of the present financial year being 863, viz. 794 on the effective, and 69 on the retired list.

RANK.	£ s d	April, 1859.	Since joined.	Promoted or withdrawn.	Deceased.	April, 1860.
EFFECTIVE LIST.						
General, Regimental, and Field Officers paying annually	1 5 0	130	+12	— 2	— 2	=138
Captains	0 16 0	298	+46	—18	— 9	=317
Lieutenants and Quarter-Masters	0 10 0	302	+83	—46	...	=339
RETIRED LIST.						
General, Regimental, and Field Officers	1 5 0	10	+ 4	...	...	=14
do. do.	0 7 6	15	...	...	...	15
Captains	0 16 0	12	+ 9	—...	...	=21
do.	0 5 0	21	...	— 4	...	=17
do.	5 0 0	1	...	...	...	1
Lieutenants	0 10 0	5	...	4	...	= 1
		794	154	74	11	863

The Committee also submit an abstract of accounts for the past year, shewing a balance credit of £1180 9s. 1½d., exclusive of the property belonging to the Institution.

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ABSTRACT OF ACCOUNTS FOR THE YEAR 1859-60.

INCOME.		£.	s.	d.
Balance Creditor, 1st April, 1859 ...	Consols Stock	1200	0	0
	Cash	54	4	0½
Subscriptions		655	11	6
Dividend on Consols		34	13	0
General Printing		87	2	7
Drawing	Instruction	13	5	6
	Materials	27	3	0
Chemistry		41	0	2
Mathematics		4	18	0
Photography		15	2	2
Turning		27	7	4½
Stationery		13	18	6½
Library		7	18	0
Lectures		3	13	6
Due Messrs Cox & Co.		21	14	5
Total		£2207	11	9½

EXPENDITURE.		£.	s.	d.
Chemistry		40	18	11
Drawing		63	0	0
Mathematics		21	0	0
Printing	Paper	111	0	0
	Wages	268	9	3
	Type	57	0	0
	Lithographer	21	12	0
	Materials	14	12	6
Furniture		3	14	0
Instruments		38	0	9
Insurance		10	0	0
Library		61	6	3
Museum		55	11	6
Observatory		6	0	0
Photography		53	6	4½
Postage and Parcels		16	18	6
Stationery		27	0	0
Transcribers		1	0	9
Turning		39	12	7½
Wages		60	16	6
Incidental		27	10	4
Lectures		6	18	0
Balance Creditor	Consols Stock	1200	0	0
	Cash with Secretary	2	3	6½
Total		£2207	11	9½

ROYAL ARTILLERY INSTITUTION,
April 1, 1860.

A. NOBLE, Captain, R.A.,
Secretary and Treasurer, R.A.I.

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Classes.—The French, German, and Surveying Classes, all of which are free of charge to every Member of the Institution have met regularly during the past year.

For some time the Mathematical and Drawing Classes have been discontinued, but will probably be renewed during the present summer.

The Committee again beg to draw attention to the advantages which the Institution offers to officers at out stations who may wish to apply themselves to any special study, in volunteering to bear one-third of the expense of a class for the study of any subject whatever, whenever as many as three officers combine for the purpose. The regulations under which this assistance is given, will be found at p. 16, Vol. I. of the "Occasional Papers."

Photography.—As a very large body of the regiment take much interest in Photography, the Committee have during the past year given this department much anxious consideration, and have spared no expense to make the Institution Establishment the most perfect of its kind. During the past year, two cameras, a portrait and a landscape, capable of taking pictures respectively 10×8 and 11×9 (both Ross' lenses), and an elaborate camera stand, the whole with every lastest improvement, have been added to the Photographic Room.

Considerable difficulties have however been experienced in making this class work satisfactorily, and several changes in the existing regulations will probably have to be made.

With the present arrangements of an Institution, both the blunders of the inexperienced are extremely likely to destroy the labours of the more advanced, and it seems probable that this system will have to be abandoned, but the Committee will endeavour in every possible way to meet the wishes of the Members, and they take this opportunity of tendering their thanks to Major Shaw for his kindness in devoting time and trouble to the instruction of a Photographic Class.

Chemistry.—The attendance at this class, under the superintendence of Messrs Abel and Bloxam, has been regular and numerous.

The principal additions to the Laboratory have been Hoffman's and Griffin's gas furnaces, and the Committee believe the Laboratory to be well adapted for the prosecution of chemical researches of nearly every nature.

To the excellent microscope belonging to the Institution, the gift of Sir Robert Gardiner, the Committee have added an object glass of higher power ($\frac{1}{8}$ in. focal distance), and as several of the objects were found to be injured by exposure to the air and dust, a microscopic cabinet has been purchased for their preservation.

Printing and Publication.—Publication, from the widely scattered stations of the regiment, and from the absence for long periods from head quarters of very many officers, has naturally become one of the leading operations of the Institution. The first volume of the "Occasional Papers" is now completed, and the table of contents and index will shortly be issued.

The system which has been of late followed with reference to the two Institution publications, the "Occasional Papers" and the "Proceedings," may perhaps, for general information, be here alluded to.

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In the "Occasional Papers" are published all papers of minor interest, accounts of experiments, translations of important foreign memoirs connected with artillery, &c., &c., while the "Proceedings" are as far as possible confined to original papers by artillery officers. The following is a List of the papers which have been read at the Evening Meetings since the last General Meeting, to which the Committee refer with great satisfaction, and to all of the gentlemen named they beg to tender their thanks.

Remarks on the "Report of Practice," carried on in 1858, in the Plumstead Marshes, with 9-pr. Field Guns, for the purpose of ascertaining the comparative merits of the 2½ lbs. and 3 lbs. charges. By Captain Haultain, R.A.

Remarks on a new pattern Limber and Ammunition Wagon, with Observations on different Systems of draught. By Capt. Leslie, R.A.

An account of the clearing of Loaded Guns, sent from the Crimea to the Royal Arsenal, Woolwich, by Colonel F. Eardley-Wilmot, R.A., Superintendent Royal Gun Factories.

On the Chemical Theory of Gunpowder. By R. Bunsen and L. Schishkoff, communicated by F. A. Abel, Esq., Director of the Chemical Establishment of the War Department.

Remarks on the paper by Bunsen and Schischkoff, "On the Chemical Theory of Gunpowder." By F. A. Abel, Esq., Director of the Chemical Establishment of the War Department.

Note, on some of the effects of severe pressure upon the properties of gunpowder. By F. A. Abel, Esq., Director of the Chemical Establishment of the War Department.

Note, on the products of decomposition of Würtemberg Cannon-powder, determined by Dr J. Linck.

Notes on the Early History of the Royal Regiment of Artillery, chiefly compiled from the Manuscript Notes of the late Col. Cleaveland. By Captain Yonge, R.A., Dept.-Assist.-Adj.-General.

French Regulations relative to Sieges, particularly as regards the Artillery, communicated by Colonel Smythe, R.A.

Bessemer's Process of making Steel and Malleable Iron. By Colonel Eardley-Wilmot, R.A.

Uranus and his Satellites: an examination of the Paradox. By Captain Drayson, R.A.

Experiments on the Strength and Elasticity of Timber, made in the Royal Arsenal, Woolwich, 1852–1859. By Major H. Clerk, R.A., F.R.S.

Remarks upon the importance of the study of the "Military Art," by the Scientific Corps. By Captain T. Mahon, R.A.

Report, relative to the experiments made in 1857, with two 12-pr. howitzer guns of cast steel, supplied from the establishment of M. Krupp. Translated from the French.

On the History of Elongated Projectiles, (chiefly extracted from the Records of the Ordnance Select Committee). By Lieut.-Colonel Burrows, R.A.

On inspections of Field Artillery. By Captain Robertson, late R.A., communicated by General Sir R. J. Dacres, K.C.B., &c. &c. Commandant.

Report on some of the Applications of Soluble Glass. By F. A. Abel, Esq., Director of the Chemical Establishment of the War Department.

Historical Notes connected with the Royal Regiment of Artillery. By Captain Colomb, R.A.

List and Description of Old Guns and Mortars, English and Foreign, in the Royal Military Repository at Woolwich, in the Royal Arsenal at Woolwich, and in the Tower of London. By Lieut. Edgar, R.A.

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Remarks on the adaptation of Existing Works of Fortification to the present Requirements of Artillery. By Lieut. H. Webber, R.A.

Balistic Experiments, made in Russia, in 1858. Translated from the French of M. Navez. By Major FitzHugh, R.A.

A Slight Sketch of the Bengal Horse Artillery System. By Lieut. W. T. Milman, Royal Horse Artillery.

On Littoral Warfare. The Fire of Artillery in repelling the boats of an invading Force. By Captain Robertson, late R.A., communicated by Major-General Sir R. J. Dacres, K.C.B. &c. &c. Commandant.

Military Manufacturing Establishments in France. By Colonel Smythe, R.A.

Historic Facts connected with the Regiment, from the Journal of an officer of the Royal Irish Artillery. By Captain Colomb, R.A.

M. Magnus, On the deviation of Projectiles. Translated from the French of M. Delobel: by Major FitzHugh, R.A.

A new Sytem of Fortification, applied to existing arms. By Lieut. Doull, R.A.

The publication of the third edition of the "Hand Book" has been postponed, on account of the state of transition in which Artillery matériel has lately been, and on account of the necessity of giving more details with respect to rifled artillery. The edition is, however, now in the press, and will shortly be published.

The brigade and seniority lists of the regiment continue to be published monthly, and the constant demand on the printing press shews how useful it is found to be by the officers of the regiment.

Library.—In making additions to the library, the Committee have adhered to the principle of making it a special one, as complete as possible in artillery, and also in those departments of science which the Institution is intended to promote.

A list of the donations and purchases during the past year accompanies the report.

A reading room has been established in which new books are placed for one month, and in which are also placed the following scientific and professional journals and periodicals received by the Institution.

Proceedings of the Royal Society.
" " Royal Geographical Society. } Presented by Col. Smythe.
Journal of the Royal Geographical Society. }
Le Spectateur Militaire.
Journal des Armes Spéciales.
Canadian Journal of Industry, Science, and Art. (Presented by Captain Noble).
Journal de Mathématiques pures et appliquées.
Philosophical Magazine.
Journal of the United Service Institution. (Presented by the Council).
Comptes Rendus hebdomadaires des Séances de l'Académie des Sciences.
Crelles' Journal.
Journal für die reine und angewandte Mathematik.
Journal des Sciences Militaires.
Monthly Notices of the Royal Astronomical Society. (Presented by Captain Noble).
Journal of the Society of Arts.
Photographic Journal. (Presented by Mr Abel).
Proceedings of the Geological Society.

The Committee believe that this reading room has been found useful.

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Museum.—The objects which the Museum receives may be divided into four classes; objects of general interest, objects of special interest to artillery officers, objects for the natural history museum, and objects for the geological and mineralogical museum.

With regard to the first two heads but little need be said, suitable objects will present themselves to every officer. The Institution is however very defective in specimens of artillery matériel of foreign powers. It has also been suggested that sketches or photographs of the various foreign stations to which artillery officers are liable to be sent, would prove extremely interesting. The Secretary of State for War has directed that the Institution should receive a copy of all photographs taken by the various departments, and a most useful series of these photographs has already been received.

During the past year, considerable progress has been made in the arrangement of both the natural history and the geological museums.

A list of the various donations to the museum accompanies this report, but the Committee cannot pass without notice the magnificent donation by Captain Blakiston, of the various birds collected by him during his connexion with the North American exploring expedition, the scientific value of which can hardly be overrated. The Committee have also to thank Dr Roche for a commencement for the birds of India.

The rules which have been, and which probably will be adopted in the arrangement of the birds of the natural history museum (the Institution collection consisting in a large measure of birds), may be briefly sketched. It would not be advisable, even were it practicable, to set up the various ornithological specimens which may be received from all parts of the world. The plan employed is as follows. Birds, for example, are generally divided into seven orders. To each of these orders one of the large side cases in the natural history museum is devoted. In each case will be set up the most typical representative of the various families and genera into which the order is subdivided, and each case will thus contain the type form of that particular order. The only departure which the Committee propose from the above rule is in the case of British birds, specimens of all of which it is proposed to mount.

The principal collection of the Institution, which it is hoped will be as complete as possible, will be arranged in drawers in cases in the centre of the museum. These cases will be arranged according to the geographical distribution, a certain number being appropriated to each of the five great divisions of the globe. A very good commencement on this plan which offers great facilities for the comparison of kindred species obtained from different parts of the world, has already been made with the birds of America, and drawers from the cases illustrating the arrangement are placed on the table.

Even the above method could probably not, from deficiency in room, be followed in the case of mammalia. The collection of the Institution under this head is however much too small to admit of any attempt at classification.

The Committee however deem it right to call attention to the fact that the value of specimens will be largely increased if certain information with respect to them be also furnished, and they refer with great pleasure to Captain Blakiston as an instance of a scientific collector who has done great

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service to ornithology; several eggs, for example, obtained by that officer having, prior to his discovery, been quite unknown. Duplicates of some of the rarer ones have been forwarded to the Smithsonian Institution for insertion in the work now being published by them on the Oology of North America.

The information which the Institution is desirous of obtaining with the specimens, will be found at p. 401 of the "Occasional Papers." Specimens from any part of the globe will be gladly received, and are more particularly wanted from Asia, Africa, and Australia.

A series of humming birds is also much wanted.

Several valuable additions have been made during the past year to the collection of eggs, and this interesting department the Committee trust soon to render more tolerably complete. Several additions have also been made to the insect collection, an admirable nucleus for which the Institution now possesses.

There have not been very many additions made to the geological and mineralogical specimens, which have been admirably arranged for purposes of study by Mr Baily and Professor Morris respectively. The fossils are arranged according to their formation in the side cases, the minerals according to their chemical composition in the centre of the room. A list of the chief mineralogical deficiencies was a short time ago published in the "Occasional Papers." Specimens of minerals, and of fossils in particular, are much wanted from nearly every colony.

In conclusion the Committee cannot but point out that since the sanction of the Lords of the Admiralty has been granted to the transmission free of expense, by Government vessels, of packages addressed to the Secretary, the Institution has opportunities of forming a collection which may not only prove of the greatest service to its members, but may add in the scientific world to the already high standing of the Regiment. They therefore trust that advantage will be taken of the liberal concession which has been made by their Lordships.

The following officers retire from the Committee by rotation, in accordance with Rule IV. viz.

Captain Forbes, Major Owen, and Lieut. Gilmour.

During the past year the Committee in accordance with Rule IV. elected provisionally to serve on the Committee,

Lieut.-Colonel Travers, Lieut.-Col. Talbot, Major Young, Captain Mahon, and Lieut. Molony.

List of Donations, since last Annual Meeting.

Australian parrot	Mr Dixon.
Moose deer's head	Lieut.-General Sir W. F. Williams.
Helmet (artillery) 1854 pattern	Major Clifford, R.A.
Horse Artillery pelisse	Major-Gen. Bloomfield.
Chinese shield, and several minerals	Captain Close, R.A.
Specimens of gunpowder of various nations, with their analyses	Mr Abel.

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Moose call	Lieut. L'Estrange, R.A.
Case of ducks	
Case of Indian butterflies	Mr Whitely.
Collection of some of the rarer British birds	
Maps of the seat of war	Director of the Topographical Department.
Head of a fossil ichthyosaurus	Captain Clark, R.A.
Hair, and part of dress of Tantia Topee	Dr Fogo, R.A.
Gold lace jacket, busby, plume, sash, and lines, R.H.A.	Major-Gen. Bloomfield.
Case of insects	Mr Whitely.
Map of St Helena	Major Palmer, R.A.
Austrian soldier's cap-plate from Solferino	
Bullet found on the body of an Albanian chief killed before Sevastopol	Major Reilly, C.B., R.A.
Two Indian helmets	Colonel Phillpotts, R.A.
Sardinian soldier's water bottle	do
Photograph of eastern gate of the baptistry at Florence	Lieutenant Blackwell, R.A.
Shell of French 12-pr. gun (rifle) from Magenta	Captain LeMesurier, R.A.
Collection of birds of North America	Captain Blakiston, R.A.
Crystals of Topaz from Ceylon	Major M'Crea, R.A.
do Sapphire do	
Eight Departmental photographs, Royal Gun Factories	Secretary of State for War.
Collection of birds of India, and Cape of Good Hope	Assist.-Surgeon Roch, R.A.
Nine photographs, Royal Engineer Establishment, Chatham	Secretary of State for War.
Diver's helmet, taken at Kertch	
Coffee-pot used by Napoleon I.	
Horns of extinct Irish red deer	
Native bread from Van Dieman's Land	Col. Eardly-Wilmot, R.A.
Russian tea-urn from Sevastopol	
Specimen of ancient urn pottery	
Russian gunner's powder horn and pouch	
Fossils	
Three Indian matchlocks	
One tulwar	Lieut.-Col. Adye, C.B., R.A.
One Indian shield	
Two Indian shields	Major Young, R.A.
Beaver cuttings (Halifax)	Colonel Burn, R.A.
Spunk from yellow birch	Captain Hardy, R.A.
Pair of Arab shoes	
Persian shield silver studded	Captain Bayly, R.A.
Topee worn by the Aden Jews	
Indian shield, transparent hide	
South American bow and arrows	Captain Close, R.A.
Specimens of various deep sea telegraph cables	M. Riddell, Esq.
Battle axe, Esquibo	Colonel Tulloh, R.A.
8th Vol. of "Professional Papers of the Royal Engineers" (new series)	Colonel Bainbrigge, R.E.
Pamphlets on Malta fossils, and geology of Malta and Gozo	Colonel Lefroy, R.A.

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Pamphlets on the Sweedish artillery	Lieut.-Col. D'Aguilar, R.A.
Minute on the changes and re-organization of the Royal Artillery	Gen. Sir R. Gardiner, K.C.B.
Hawes, Rifle Ammunition, being notes on the manufacture as conducted in the Royal Arsenal.	The author.
Liouville Journal de Mathématiques	Captain Noble, R.A.
Examination Papers, Royal Military Academy.....	Colonel Wilford, R.A.
Practice tables, Prussian artillery	F. A. Abel, Esq.
Jackson, Minerals and their uses	Professor Tennant.
Memoirs of the Astronomical Society, July 1859.....	Captain Noble, R.A.
Artillerist's Manual	Major Griffith, R.A.
Enchiridion of fortification, 1645	Lieut. F. M. Smith, R.A.
Diagram of comparative errors of various guns.....	Captain Noble, R.A.
Official account of the siege of Sevastopol.....	Secretary of State for War.
Rhode's, Major, Tents and Tent Life	Lieut.-Col. Broughton, R.A.
Ellis, Lieutenant, R.A., Military notes, 1859.....	The author.
Journal of the Royal Geographical Society, Vols. XXIV. XXV. XXVII. XXVIII.	Colonel Smythe, R.A.
Proceedings of the Geographical Society	do
Rate Book, Ordnance Department, Bengal, 1858...	Major Young, R.A.
Bengal Artillerist's Note Book	
Journal of the United Service Institution, Vol. III. No. 10	By the Council.

List of Books purchased since last General Meeting.

Ufano Vraye Instruction de l'Artillerie, 1635.
Scoffern (*J.*), Projectile Weapons of War.
Nichol (*J. P.*), Cyclopædia of the Physical Sciences.
Flachat, Barrault, et Petiet, Fabrication de la fonte et du Fer.
Fraser (*Sir Aug.*), Letters during the Peninsular and Waterloo campaigns.
Thiers (*M.*), Histoire du Consulat et de l'Empire.
Greene (*Capt.*), R.A., Sketches taken during the Campaign in India.
Straith (*H*), On Fortification.
Morin (*A.*), Leçons de Mécanique et Pratique.
do Resistance des Materiaux.
Le Besgue, Exercices d'Analyse numerique.
Douglas (*Sir H.*), Naval Warfare with Steam.
Bormann, Shrapnel Shell.
Greener (*W.*), on Gunnery.
Tables of Specific Gravity.
James, Military Dictionary.
Flavigny (*le Vicomte de*), Examen de la Poudre.
Simmons (*T.*), on the effect of Heavy Ordnance directed against Ships of War.
Comptes Rendus.
Du Parcq., Elements d'Art et de Histoire Militaire.
Philosophical Magazine, 1859.
Majendie (*Lieut.*), R.A., Up among the Pandies.
Noad (*H. M.*), Manual of Electricity, 1857.
Bacon (*Francis*), Works of.
Description of Patents, 1859.
Didion (*Col.*) d'Artillerie, Lois de la resistance de l'air sur les Projectiles, 1857.
——— Calcul des Probabilités appliqué au tir des Projectiles, 1858.

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Didion (*Col.*) Cours Elémentaire de Balistique.
Brunet (*M. J.*), Histoire Générale d'Artillerie, 1842.
Decker (*Col.*) d'état Major Prussien, Expériences sur les Shrapnels faites chez la Plupart des Puissances de l'Europe. Traduit par MM. Terquem et Favé, 1847.
Expériences Comparatives faites à Gavre, 1836, entre des Bouches à feu en fonte de fer d'Origine Française, Anglaise, et Suedoise, 1837.
Expériences sur Différentes Espèces de Projectiles Creux, 1837.
Expériences de Bapaûme, Rapport fait à M. le Ministre de la Guerre par la Commission mixte des Officiers d'Artillerie et du Génie, 1852.
Expériences (suite des) d'Artillerie Exécutées à Gavre, Recherches Expérimentales sur les Déviations des Projectiles, 1844.
Expériences d'Artillerie Exécutées à Lorient à l'aide de Pendules Balistiques, 1847.
Expériences d'Artillerie Exécuteés à Gavre, 1841.
Chertier, Nouvelles Recherches sur les feux d'Artifice.
Delobel, Revue de technologie Militaire, Vols. I. II.
Navez, Expériences de Balistique.
——— Instruction sur l'appareil Electro Balistique.
Prion, Essai de Fortification éclectique.
Gauss (*C. F.*), Theoria Motus Corporum Cœlestium.
Grant (*R.*), History of Physical Astronomy, 1852.
Monge, Description de l'art de fabriquer les Canons.
Knox (*Capt.*), Campaigns in North America, 1757-60.
Ramsay, Geological Map of England and Wales.
Forbes (*Prof.*), History of the European Seas, 1859.
Lushington, Italian War, 1848, 49.
Jervis (*Capt.*), R.A., Our Engines of War, and how we got to make them.
Westwood (*J. O.*), British Butterflies, and their transformations.
Macdougall (*Lieut.-Col.*), The Theory of War.
——— Campaigns of Hannibal, 1858.
Owen (*Prof.*), Lectures on Comparative Anatomy, and Physiology of the Invertebrate Animals, 1855.
Magnus, Memoire sur la déviation des Projectiles.
Marion, Chronologie des Machines de Guerre et de l'Artillerie depuis Charlemagne, 1828.
Louis Napoleon Bonaparte, Empereur des Françias, Etudes sur le passé et l'avenir de l'Artillerie, 1851.
Guerre d'Orient, Service de l'Artillerie.
Jamin (*M. J.*), Cours de Physique de l'École Polytechnique, 1859.
Péclet (*E.*), Traité de la Chaleur, 1860.
Kreigsfeuerwerkerei, für die Königlich Preussische Artillerie, 1860.
Proceedings of the Palæontographical Society, 1857.
Bazancourt (*le Baron de*), la Campagne d'Italie de 1859.
Stein (*Dr F.*), Der Organismus der Infusionsthiere.
Philosophical Magazine, 134 vols.
Nicholson's Journal, 38 vols.
Thompson's Annals of Philosophy, 20 vols.

Proposed by Captain Freeth, seconded by Lieut. Crawford, and carried.

That the Report of the Committee be received and adopted.

The Secretary, by the direction of the Committee, drew the attention of the Meeting to the subscriptions paid by certain retired members of the

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Regiment who retired prior to the time when the subscriptions were increased, and who now receive both the Institution publications while their subscriptions would not cover the expense of publication. After discussion it was

Proposed by Sir R. Dacres, seconded by Lt.-Col. Talbot. and carried,—

That before next year's subscriptions fall due a circular be addressed to the officers in question requesting them to inform the meeting whether they would prefer receiving only the "Proceedings" at their present rate of subscription, or both "Proceedings" and "Occasional Papers" at an increased rate of 10*s.* per annum.

Proposed by Colonel Dalton, R.A., seconded by Major-General Sir R. Dacres, and carried,—

Captain Noble having announced his appointment to the Office of Assistant Inspector of Artillery, and his consequent resignation of the Secretaryship of the Royal Artillery Institution, the Committee take this opportunity to record their grateful sense of the able manner in which he has at all times conducted the business of the Institution; and, much as they regret the loss of his valuable services, they cannot but rejoice to find that his high talents are appreciated, and beg to tender him their warm congratulations on his being selected to fill so important a post as that to which he has been nominated.

Proposed and carried unanimously,—

That this Meeting approve of the elections made by the Committee to replace vacancies caused by removals from the garrison.

Proposed and carried unanimously,—

That the following officers be elected to serve on the Committee, in accordance with Rule IV. viz.,

Captain Dames, Captain Noble, Lieutenant Crawford.

The Committee will therefore stand thus,—

PATRON AND PRESIDENT:

General H.R.H. The Duke of Cambridge, K.G., &c., &c.

VICE-PRESIDENT:

The Commandant.

MEMBERS:

The Deputy-Adjutant-General.
The Assistant-Adjutant-General.
The Secretary Ordnance Select Committee.
The Brigade-Major.

Col. C. J. Dalton.	Captain Noble.
Col. G. H. R. Kennedy.	Captain A. H. King.
Lt.-Col. Travers.	Dr Fogo.
Lt.-Col. Talbot.	Captain A. Hutchinson.
Major C. F. Young.	Lieut. Crawford.
Captain Mahon.	Lieut. Y. D. Majendie.
Captain Dames.	Lieut. C. M. Molony.

Captain Noble, *Sec^{y}. and Treasurer.*

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[CONFIDENTIAL.]

Report of Ordnance Select Committee, Nos. 1178, 1263, *Oct.* 17, 1860. *Iron Embrasures of Special Construction at Shoeburyness. Communicated by direction of the* SECRETARY OF STATE FOR WAR.

Colonel St GEORGE, C.B., R.A.
Captain SIR W. WISEMAN, Bt., R.N.
Colonel ROBINSON, R.E.
Colonel GREATHED, C.B., H.P., Unatt.
Lieut.-Colonel F. CAMPBELL, R.A.
Colonel LEFROY, R.A., *Secretary.*

IRON EMBRASURES OF SPECIAL CONSTRUCTION AT SHOEBURYNESS.

1. IN reference to the experiments carried on at Shoeburyness on the 9th, 20th, and 21st September, against the iron embrasures of special construction, one being manufactured by Messrs Thorneycroft, and the other by the Mersey Iron Company, the Committee beg to forward, for the information of Mr Herbert, the following summary of the results of the practice.

The Committee are about to institute further experiments against the Thorneycroft embrasure, unsupported by the masonry at the back, with a view to ascertain if the immediate backing of the masonry tends to prevent the disintegration of the iron plates; and when this trial is concluded, a full and detailed report on the whole of the experiments, together with photographs illustrating the general effect, will be submitted.

Summary of the Results of Experimental Practice carried on in the presence of the Ordnance Select Committee at Shoeburyness, on the 19th, 20th, and 21st September, 1860.

IRON EMBRASURES.—Practice at 400 yards.

Grape Shot.

2. Five rounds, service grape, 68-pr. of 95 cwt., 16 lbs. charge, each round containing fifteen balls.

Five rounds, service grape, 32-pr. of 56 cwt., 10 lbs. charge, each round containing nine balls, were fired at each embrasure.

Eleven balls struck the left embrasure (Thorneycroft's), one went through the breast transom of carriage. Nos. 5, 6, and 7 of the gun detachment struck. The detachment was represented by figures, rudely cut in ¾-in. deal boards, and set up in the positions of the several numbers.

Nine balls struck the right embrasure (Mersey iron), of which two struck the exterior of right cheek, one the interior; one struck the exterior of left cheek, and one the interior; three struck top sill, and one bottom. Nos. 2, 3, 5, 6, 7, and 8 of the gun detachment struck. Seventy-four hits in the masonry.

Indentation on both the iron embrasures ¼-in.

Five rounds of 68-pr., and five rounds 32-pr. grape repeated at both embrasures.

Fourteen balls struck the left embrasure (Thorneycroft's), and one the muzzle of the gun. No. 5 of the gun detachment struck.

Six balls struck right embrasure (Mersey iron), one the mantlet. Nos. 2, 3, and 6, of gun detachment struck. Seventy-three balls struck masonry.

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Practice at 600 yards.

Segment Shells.

3. Fifteen rounds, Armstrong's 25-pr. segment shell, weight 25 lbs. 5 oz., with time and concussion fuzes; ten rounds concussion to act, five ditto time to act.

Ten rounds were fired at left embrasure (Thorneycroft's).

Five rounds were fired at right embrasure (Mersey iron).

Twenty-five splinters struck the iron of left embrasure, and two struck the gun. Gun detachment all struck. Each shell contains forty-eight segments.

Twenty splinters struck iron of right embrasure, three the muzzle of gun. Gun detachment all struck.

Cast-iron Shot.

4. Ten rounds cast-iron shot, 67·5 lbs., fired from 68-pr. at left embrasure (Thorneycroft's), charge 16 lbs.; six shot struck the iron; the muzzle of the gun knocked off; keystone started; parapet above iron work cracked through; sill-stone cracked and started. Average indentation in iron 1½-ins. Ironwork started 1-in. at top and ½-in. at bottom.

5. Twelve rounds cast-iron shot, 67·5 lbs. weight, fired from 68-pr., at right embrasure (Mersey iron). No. 3 shot struck left top of embrasure, and passed through; No. 12 went through embrasure, and struck gun carriage; sill-stone cracked and started; a hole 1 ft. 3 ins. deep in granite under ironwork; the sides of embrasure started ½ in.

6. Five rounds of solid cast-iron shot were also fired from Armstrong's 40-pr. at the same embrasure; one shot hit right cheek, one broke the sill of embrasure, hit lip of gun and struck below ironwork and broke the stone; three shot struck right cheek of embrasure, of which one struck right front edge, glanced off to opposite inner edge, then struck gun on muzzle, cracking it; one shot went clean through masonry under iron work, split bottom sill of embrasure, and struck gun-carriage, disabling it completely; another shot ricochetted from right to left cheek, and then passed in—left cheek started 1 in.

7. Nine rounds, cast-iron, solid shot, weight 40 lbs., fired from Armstrong's 40-pr., at left embrasure (Thorneycroft's); five shot struck the inner; two passed through embrasure, struck gun-carriage.

Depth of indentation ⅛ and 1½ ins.

Wrought-iron Shot.

8. Five rounds of wrought-iron flat-headed shot, mean weight 41¼ lbs., fired from Armstrong's 40-pr., at left embrasure (Thorneycroft's); three shot struck the right side of the iron, two hitting nearly on the same place, making an indentation 1 in. deep. Average indentation caused by single shot, ½ in.

One shot grazed on the right cheek of embrasure, struck muzzle of gun, and then the carriage, rendering the latter unserviceable.

9. Three rounds of solid shot, flat-headed, homogeneous iron, fired from Armstrong's 80-pr. at left embrasure (Thorneycroft's). Mean weight, 97½ lbs.

None struck ironwork. Practice with these projectiles was discontinued at Sir William Armstrong's request.

10. Five rounds wrought-iron shot, 71½ lbs. weight, fired from service 68-pr., with 16 lb. charges, at left embrasure (Thorneycroft's).

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Two shot struck the ironwork fair, with an average indentation of 1½ ins., of which one struck the top sill of ironwork, breaking in the brick arch backing behind.

11. Five rounds of wrought-iron flat-headed shot, weight 41 lbs. 2 oz., were fired from Armstrong's 40-pr. gun, at right embrasure (Mersey iron).

12. Seven rounds of wrought-iron flat-headed shot, 82¾ lbs., were fired from Armstrong's 80-pr., 10 lbs. charge, at left embrasure (Thorneycroft's); four shot struck ironwork, average indentation, 1¼ in.; one went through the embrasure; gun-carriage and slide disabled, key stone started, and a breach in brick arch behind top of ironwork; right springer started.

13. Four rounds wrought-iron flat-headed shot, 82¼ lbs., fired from the same gun at right embrasure (Mersey iron), three shot struck ironwork, one of which struck fair on right cheek; one struck right cheek and glanced in, one struck bottom sill and glanced in through breach underneath ironwork; gun-carriage disabled; right springer started on its bed; key-stone driven back ¾ in., and a clean breach through sill-stone.

14. Recapitulation of Number of Rounds fired against Left Embrasure (Thorneycroft's).

Date. 1860.	Number of rounds.	Nature of Ordnance.	Charge. lbs.	Charge. oz.	Projectile. Nature.	Projectile. Weight. lbs.	Range. yds.	Remarks.
19th Sept.	10	68-pr. gun	16	0	Service grape	69	400	
„	10	32-pr. gun	10	0	Service grape	32¼	400	
„	10	25-pr. (Armstrong)	3	2	Segment shell	24½	600	
„	10	68-pr. gun	16	0	Cast-iron shot.	67·5	600	
„	9	40-pr. (Armstrong)	5	0	Cast-iron solid shot	40	600	
20th Sept.	5	40-pr. (Armstrong)	5	0	Wrought-iron (flat-headed shot)	41½	600	
„	3	80-pr. (Armstrong)	12	0	Solid shot (flat-headed) homogeneous iron	97½	600	
„	5	68-pr. gun	16	0	Wrought-iron shot	71½	600	
21st Sept.	7	80-pr. (Armstrong)	10	0	Wrought-iron (flat-headed)	82¼	600	

GENERAL OBSERVATIONS.—*Left Embrasure (Thorneycroft's).*

15. The ironwork is started about 1 in. on the right side, and 1½ ins. on the left side, it is bulged out along the centre about half an inch. The masonry is a good deal shattered round it; an opening has been made over the top sill, about 2 ft. deep; the small brick arch behind and backing the top sill has been destroyed.

Inside.

16. The sill-stone is cracked and started back, both springers also cracked; all the key-stones, three, are started, and the right one cracked: a crack extends upwards through the brickwork, from the right corner of the right and centre key-stones. The gun is totally disabled, all the muzzle being knocked off; the carriage is destroyed, and slide much injured.

17. *Indentations.*

Service grape shot	½ inch.	Armstrong's 80-pr.	1 inch.
Armstrong 40-pr. cast-iron shot ...	¼ „	Service 68-pr. cast-iron	1¼ „
Service 68-pr. wrought-iron shot...	1½ „	Armstrong's 40-pr. wrought-iron shot	¼ „

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18. Recapitulation of Number of Rounds fired against Right Embrasure (Mersey Iron).

Date.	Number of rounds.	Nature of Ordnance.	Charge.	Projectile.		Range.	Remarks.
				Nature.	Weight.		
1860.			lbs. oz.		lbs.	yds.	
19th Sept.	10	68-pr. gun	16 0	Service grape	69	400	
„	10	32-pr. gun	10 0	Service grape	32¼	400	
„	5	25-pr. gun (Armstrong's)	3 2	Segment shell.	24½	600	
„	12	68-pr. gun	16 0	Cast-iron.	67½	600	
21st Sept.	5	40-pr. gun (Armstrong's)	5 0	Wrought-iron (flat-headed)	41½	600	
„	5	40-pr. gun (Armstrong's)	5 0	Solid cast-iron shot	40	600	
„	4	80-pr. gun (Armstrong's)	10 0	Wrought-iron (flat-headed)	82½	600	

GENERAL OBSERVATIONS.—*Right Embrasure (Mersey Iron).*

19. The right cheek of ironwork is started ½ in., and the left 1¼ ins., the masonry in face is much damaged about the iron work; there is a clean breach through under the bottom sill, 2 ft. 6 ins. wide at the neck, and 6-ft. at the face.

Inside.

20. The sill-stone is completely shattered; right springer is cracked through vertically at 1 ft. 8 ins. from neck of embrasure, and a large fragment, weighing nearly 1 cwt., broken off and started in its bed. The key-stone is cracked across in two places, and started back ¾ of an inch; two cracks extend upwards in rear face of work; from upper corners of key-stone, the cracks continued through top of work, disturbing and raising some of the blocks. The brickwork in rear is much shaken; the gun has been struck several times on its muzzle, and is disabled; the breast and rear transoms, and right cheek of carriage much injured, stool bed, quoin, and elevating screw destroyed. The slide is not much injured.

21. *Indentations.*

Service grape shot ..... ¼ inch.
Armstrong's 80-pr. wrought-iron shot (only one hit fair) 1¼ „

J. ST GEORGE.

Further Report, No. 1263, *dated 26th November,* 1860.

EXPERIMENTAL EMBRASURE OF THORNYCROFT'S ROLLED IRON AT SHOEBURYNESS.

22. The Committee have now the honour to report, that they have completed the practice against the Experimental Embrasure, made of Thorneycroft's rolled iron, without the support of stone-backing.

23. The embrasure consists of an opening of 23 by 39 inches, in a screen of rolled iron, composed of 14 slabs, 10 inches wide, 4 inches thick, and (the whole slabs) 12 feet long; each slab has a mortice on one face, and a tenon on the other, by which they are connected together, and the entire structure is clamped together by a strong tie-rod at each end, which passes through bonding-irons of the same substance at top and bottom, but

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not through the slabs themselves. These bonding-irons are in turn tied to the masonry by other strong rods, above and below.

24. The iron-work weighs about 11 tons 13 cwt., and cost £175. It is strongly embedded in blocks of stone of different qualities, the respective merits of which have also been tested by the experiment, but do not form the subject of the present report.

25. After the trials of the 19th September, when the iron-work received 21 direct blows without serious injury, the stone-backing was, by Mr Herbert's direction, removed from it, leaving only an abutment of 30 inches at each end, by way of support, and the practice was renewed, on the 8th instant, from the same distance,—namely, 600 yards. On this occasion, it was struck 29 times, as under.

Blows received after the removal of the stone-backing:—

	Distance.	Charge.	Wrought or Cast-iron Shot.	Hits.
	yards.	lbs.		
Service 68-pr.	600	16	Cast	11
Armstrong's 80-pr. ...	600	10	Cast	9
" "	"	"	Wrought	1
Armstrong's 40-pr. ...	600	5	Cast	7
" "	"	"	Wrought	1
Total	.....	.....	.....	29

Adding these to the blows received before the removal of the stone-backing, we have the following for the total number of blows:—

68-pr.	20
80-pr. (Armstrong)	14
40-pr. (Armstrong)	16
	50

26. The present state of the embrasure may be thus described:—

The 4th and 5th slabs, on the left-hand side (as seen from within), having been struck on the edge, have been slid laterally on No. 6, about 1½ inch, forming a notch of that depth in the side.

The 9th slab, on the right (counting from the top), is broken, and a piece, about 12 inches long, knocked out of it.

Five out of 14 slabs have cracks in them; 4 cracks are visible in front, and 8 in rear, but the bars are not displaced; and that these cracks do not greatly diminish the strength of the structure may be inferred from the fact, that 3 of the slabs were cracked by the September practice, and, notwithstanding all the subsequent hammering, remain serviceable. In fact, with the exception of the opening caused by knocking off a portion of No. 9, which was done by an 80-pr. shot, the embrasure appears, at a little distance, as sound as ever.

The shot in question struck a part previously fractured. The dints on the iron nowhere exceed 1·5 in. in depth; there is no material difference between those produced by the wrought-iron and cast-iron projectiles. One 80-pr. shot, striking between slabs 9 and 10, at the right edge of the embrasure, partially separated them, but a succeeding blow shook them together again.

27. The Committee have no hesitation in expressing their belief, that

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this material and mode of construction is thoroughly efficient for the purpose in view. The stone-backing appears to add little, if anything, to its power of resistance, and may, in their opinion, be safely dispensed with when convenient; its removal diminishes the risk from splinters, and adds largely to the interior space.

28. As compared with an embrasure composed of a top and bottom, and two side pieces, of Mersey wrought-iron, which cost £278, or more than half as much again as the Thorneycroft embrasure, the Committee find that this form is equally convenient for the service of the gun, equally capable of resisting the destructive effect of shot, and exposes less than one-third the opening.

The neck of the Mersey iron embrasure is of the same size, but the mouth opens to an area of 19 square feet, any shot striking which glances in.

This was exemplified by the effect of 10* rounds of grape shot, fired at each embrasure from 400 yards, and by 15 rounds of 25-pr. segment shells, fired at 600 yards, which left no doubt of the difference between the embrasures in this respect, although the number of balls or segments which entered either cannot be accurately stated.

The effect was visible on the guns and carriages, and on figures in board, placed to represent gun detachments.

J. ST GEORGE.

On the determination of distances in the Field.

By Lt.-Col. H. CLERK, R.A. F.R.S.

In consequence of the introduction into the service of guns of greater precision and range, a ready means of determining the distance of the object to be fired at, becomes very desirable; and having for some time past had this subject under consideration, I have drawn up the following account of the instruments experimented with, in the hopes that it may be found interesting, and possibly lead to some more perfect form of instrument than any yet tried.

The most generally known means of ascertaining a distance, by one observation, is Cavallo's micrometer, which consists in a finely divided scale in the eye-piece of a telescope. The distance is estimated from the number of scale divisions which an object of known, or assumed, height covers; the angular value of a scale division being previously determined.

Rochon's micrometer and a very portable field glass called the "Emperor Napoleon's," are both on the same principle. (See Fig. 1, Plate I.)

The objections to this method are that, in the first place it is necessary to know the height of the object very accurately; for an error in it will cause a proportionate error in the distance: thus if the object be estimated at 5 ft., an error of $\frac{1}{10}$th or 6 in. will cause an error of 100 yards in a distance of 1000 yards. In the second place, this method is only applicable when both the top and bottom of the object are visible.

These considerations led Professor C. Piazzi Smyth, Esq., F.R.S., Astronomer Royal, Edinburgh, to devise, in November 1855, an instrument in which this principle is reversed; i.e. instead of observing the angle a distant

* Five rounds 68-pr., five rounds 32-pr.

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base line subtends, the instrument carries its own base line, and all that is necessary for the determination of the distance is a point. The same object being seen by direct vision and by reflection from each end of the base line. (See Fig. 2, Plate I.)

Thus, the head of a man above a parapet or a light at night is sufficient for the purpose.

The principle of this instrument is shewn in Fig. 3, Plate I.

At the extremities of a base line *AB* are fixed two mirrors (or prisms) *A* and *B* at about 45° to the base line. By means of a telescope *C*, at right angles to the base, a distant object (*d*) is seen by direct vision through the unsilvered part of the mirror *A*. The same object is reflected into the mirror *B*, from it to *A*, and thence into the telescope.

The distance may be determined by either of the following methods:—

(1) By turning the mirror *B* through a certain angle, until the two objects coincide, keeping the base line a constant, and referring this angle to a table for the distance (as in Fig. 4), or

(2) The mirror *B* may be made to move backwards and forwards along the base line, the angle remaining constant as in Fig. 5. In this case, the distance is determined on the principle of similar triangles (the instrument being in the first instance adjusted to some known distance), or

(3) Neither base nor angle need vary, but the distance be obtained by observing the amount of separation of the two objects as seen in the eye-piece of the telescope, these objects having been previously made to coincide at some known distance as zero.

The amount of separation can be measured either by a wire micrometer, or a finely divided glass scale, and the readings referred to a previously calculated table for the distance. (See Fig. 6).

This is the method which I found most convenient, and an instrument was made for me by Messrs Pastorelli and Co., London, in 1858, which I shall now describe. (See Plate II.)

An ordinary telescope *C* is screwed in a right angle to a bar of metal *AB* about 2 ft. in length. At the extremities of this bar, are placed the mirrors *A* and *B* at about 45°. The mirror *B* has a motion on its axis, and can be adjusted to any required angle by means of the screw *D* acting on the lever *L*. The mirror *B* being fixed vertically to the bar, the other mirror *A* can be adjusted so as to be parallel to it by means of the small screws *E*, *E*. The bar *f*, *f* acts as a support to the instrument when in use. In the eye-piece of the telescope is fixed a finely divided glass scale, of which an enlarged view is given in Plate II. The mirrors and bar are enclosed in a case, to keep off all extraneous rays of light, and by means of small shutters either of the images may be shut out so as to render the other more distinct.

The ordinary mode of using the instrument is to rest it on something flat, the top of a limber-box for instance, and direct the telescope on to the object whose distance is required to be ascertained, making it to be bisected by one of the long divisions of the scale. The reflection of the same object will also be seen on the scale at a certain number of scale divisions from the former, according to the distance of the object, and the zero of the instrument, which may be any convenient known distance. The number of scale divisions is referred to a Table previously calculated, from which the

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distance of the object is at once ascertained. In order to calculate this Table it is necessary to know the angular value of a scale division, the exact length of the base line, and the zero of the instrument.*

The first point is to determine the angular value of a scale division.

To do this the number of divisions covered by a 5 ft. rod at several distances was observed, and the angle being calculated, the value of one division was readily ascertained.

Observations to determine the value of 1 scale division $= a$.

Distance.	Angle subtended by 5 ft.	No. of divisions.	Value of one div. $= a$.	Remarks.
ft.	° ′ ″		″	
300	0 57 17	44·0	78·1	
450	0 38 12	30·0	76·4	
600	0 28 39	22·0	78·1	$a = \frac{\theta}{n}$ where
750	0 22 55	18·5	74·3	
900	0 19 6	15·0	76·4	$\tan \theta = \frac{5}{d}$
1050	0 16 22	12·8	76·8	
1200	0 14 19	11·0	78·1	d = distance.
1350	0 12 44	10·0	76·4	
1500	0 11 27	9·0	76·4	
1650	0 10 25	8·2	76·2	
Mean ...	.....	.....	76·7	$= 0°\ 1'\ 16''{\cdot}7$

Having the value of a scale division, the next point is to determine the exact length of the base line. For this purpose the instrument was set so that at a distance of 100 ft. the images of the object as seen by direct vision and by reflection should coincide. Observations were then taken of the same object at several measured distances, and the number of scale divisions between the two images noted at each distance. The length of the base line is calculated as follows:—

$$L = \tan \theta \times \frac{100\,d}{d - 100} \text{ where } \theta = an,$$

L = length of the base line,
a = angular value of one scale divisions,
n = number of divisions read off,
100 = zero = 100 ft.,
d = any other distance of observation.

The following are the observations made,—

Distance feet.	Scale Reading.	Length of base line.	Mean.
150	17·5	1·9523	
300	34·5	1·9244	
450	41·0	1·9602	
600	44·0	1·9637	
750	45·5	1·9525	ft
900	46·5	1·9455	
1050	47·8	1·9647	1·9519
1200	48·0	1·9473	
1350	48·5	1·9485	
1500	49·0	1·9523	
1650	49·5	1·9596	

* The zero of the instrument is that distance where the two images of the object as seen by reflection and direct, exactly coincide. This may be either 100 ft. or infinity, in the latter case the Sun can be used for adjustment.

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With these values of L and a, a table of distances and corresponding scale readings can be calculated by the formula

$$\tan(\theta = a\,n) = \left(\frac{L}{100} - \frac{L}{D}\right)$$

$$n = \frac{\theta}{a},$$

if 100 ft. be taken as the zero, or

$$\tan\theta = \frac{L}{D}, \quad n = \frac{\theta}{a}$$

if infinity be taken as the zero. In the latter case a distance of 100 ft. would give a scale reading of 52·5, and this could be used to adjust the instrument by, supposing neither sun nor stars were visible.

In the former case, as the distance increases, the images of the object will appear to separate more and more till they get near the edges of the object glass; whereas in the latter case, they gradually approach each other and, except at very close distances, the observations can always be made near the centre of the object glass. For this reason the latter mode of adjusting the instrument will be found preferable. As the image seen by reflection is always much more indistinct than the one seen direct, it is advantageous to shut out the latter image, after having made it to be bisected by one of the long divisions, taking care not to shift the instrument in so doing, and a small shutter is provided for the purpose.

The following Table shews the value of the scale readings for every 100 yards up to 1000 yards :—

Adjusted to zero = 100 feet.		Adjusted to zero = infinity.	
Distance.	Reading.	Distance.	Reading.
100 yards	35·0	100 yards	17·5
200 „	44·0	200 „	8·8
300 „	46·6	300 „	5·8
400 „	48·0	400 „	4·4
500 „	49·0	500 „	3·5
600 „	49·8	600 „	2·9
700 „	50·1	700 „	2·5
800 „	50·3	800 „	2·2
900 „	50·5	900 „	2·0
1000 „	50·8	1000 „	1·8

It will be seen by an inspection of this Table that although at short distances the differences of readings are considerable, yet at 1000 yards the difference for 100 yards is only 0·2 of a scale division equal to about 15 seconds. This, in clear weather and with a favourable object to observe,

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can be easily measured, and by practice the eye can readily determine tenths of a division; but as the object seen by reflection is generally very faint and indistinct, not much dependence can be placed on observations over 1000 yards, with an instrument having so short a base line as 2 ft.

In garrisons or coast batteries where portability is not essential, and there need be no limit either to the length of the base line or power of the telescope, distances of from 2 to 3000 yards could be readily determined by an instrument of this description, by a single observation of any object either by day or night.

For artillery purposes, in the field, an instrument having a base line of 5 ft. would give good results up to 2000 yards; it could always be used resting on the top of a limber-box, and could be carried in the store limber wagon without inconvenience.

For observing at night, an arrangement would have to be made to illuminate the micrometer wires or glass scale.

Although an instrument on the principle just described will give distance up to 2000 yards with tolerable accuracy, yet there may be occasions when it is necessary to determine distances up to 4 or 5000 yards. For these distances it becomes necessary to measure an actual base line, and to measure at each end the angle subtended by the object and the opposite end of the base. For general purposes a base of 100 yards will be found sufficient, and as the triangle will be isoceles, or very nearly so (see Fig. 7), the distance can be calculated by the formula $D = \tan \frac{A+B}{2} \times \frac{AB}{2}$.

The distances corresponding to the several values of $\frac{A+B}{2}$ for a constant base can be formed into a Table, and consequently all that is necessary is to observe the two angles A and B, take their mean, and refer to the Table for the distance.

The angles could be measured by a pocket sextant, but as this instrument is only divided to minutes and has an index-arm of only about 2 in. in length it will not give the angles sufficiently accurate for long distances. The following is an instrument I have made for the purpose on the principle of the optical square, and which can be applied to any telescope. (See Plate III).

It consists in placing in front of the object glass of a telescope *AA*, at an angle of 45° to it, a mirror *BB*, having a motion on its axis. An index-arm *CC* gives motion to the mirror, and enables the angle through which it has been moved to be read off on an arc *DD*, graduated to 10 seconds and supplied with a vernier and tangent scale. The index-arm is 7½ in. in length, consequently the angles can be read off with great accuracy with the assistance of a magnifying glass *KK*.

By means of the screw *E* the mirror can be adjusted exactly to 45°, so that the reading of 90° on the graduated arm shall exactly agree with a right angle. Any difference, if small, can be applied as an index error to the observation, instead of attempting to make the adjustment quite correct.

The mirror is adjusted to verticality by means of the screws *FF*.

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A cover, *a, b, c, d,* encloses the mirror and object glass, keeping out all rays of light except such as are admitted through the small openings *e, f* which are provided with sliding shutters.

By means of the foot-screws *III,* the plane of the instrument can be adjusted to that of the objects observed, if the instrument is used resting on anything flat, such as the top of a limber-box, parapet, &c.

In the focus of the eye-piece are two cross wires at right angles to each other; and the objects must always be made to coincide exactly on the vertical wire.

There being only one mirror used in this instrument, the two objects do not remain in contact in any part of the field of view, as is the case in a sextant, but separate in contrary directions, for this reason care should always be taken, that the contact is made on the vertical wire. For accurate observations the instrument should be used either resting upon something, or fixed to a light tripod stand. Having made the object seen by direct vision to be bisected by the wire (by moving the instrument on the stand), the instrument should remain fixed and the object seen by reflection be brought on to the wire by moving the index-arm. To prevent errors of collimation, (that is, suppose the vertical wire is not exactly in the axis of the telescope), the eye-piece and diaphragm carrying the wires should always be used in the same position with reference to the plane of the instrument; any error arising from this cause will then be included in the index-error.

Although having only one reflection makes the objects less steady in the field of view, and necessitates the use of a stand or some support for the instrument, yet there is less loss of light and the reflected object is more distinct. The instrument is also simpler and more compact.

The axis of the mirror, or centre on which the index-arm rotates, should be exactly over the extremity of the base line, and the instrument is supplied with a plumb-bob for the purpose of effecting this. When time permits, it will be advisable to observe both the distant object and the end of the base line by direct vision as well as by reflection, the instrument being inverted in one case, any errors arising from the mirror not being vertical to the plane of the instrument will be eliminated.

The height of an object can also be obtained by this instrument, the distance having been first determined, by making first the top and then the bottom of the object coincide with the horizontal wire in the eye-piece, the instrument remaining fixed on the stand during the observations. The difference of the two readings gives the angles subtended by the object at that distance, and the height is obtained by the formula

$$H = D \sin C,$$

when H = height; D = distance; C = angle observed. The height corresponding to the various values of C for some one distance, 1000 yards for instance, can be formed into a table, and a simple proportion will give the height for the same value of C for any other distance.

The following Tables give the distance and height of an object, the one with a base line of 100 yards, the other at a distance of 1000 yards.

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TABLE OF DISTANCES.*

Base = 100 yards.

Angle 87°	Distance. yds.	Angle 87°	Distance. yds.	Angle 88°	Distance. yds.	Angle 88°	Distance. yds.	Angle 89°	Distance. yds.
′		′		′		′		′	
0	954	30	1145	0	1432	30	1909	0	2864
2	965	32	1161	2	1456	32	1953	2	2963
4	976	34	1177	4	1481	34	1998	4	3069
6	987	36	1193	6	1507	36	2046	6	3183
8	999	38	1210	8	1534	38	2096	8	3305
10	1010	40	1227	10	1562	40	2148	10	3438
12	1022	42	1245	12	1591	42	2203	12	3581
14	1035	44	1263	14	1621	44	2261	14	3736
16	1047	46	1282	16	1652	46	2322	16	3906
18	1060	48	1302	18	1685	48	2387	18	4092
20	1074	50	1322	20	1718	50	2455	20	4297
22	1087	52	1342	22	1753	52	2527	22	4523
24	1101	54	1364	24	1790	54	2604	24	4774
26	1115	56	1386	26	1828	56	2685	26	5055
28	1130	58	1408	28	1868	58	2772	28	5371

* For distances over 4000 yards, the base line should be 200 yards, when the values in this Table will be doubled.

TABLE OF HEIGHTS.†

Distance = 1000 yards.

Height.	Angle.	Height.	Angle.	Height.	Angle.	Height.	Angle.	Height.	Angle.
ft.	° ′	ft.	° ′	ft.	° ′	ft.	° ′	ft.	° ′
5	0 6	65	1 15	125	2 24	185	3 32	245	4 41
10	0 12	70	1 20	130	2 29	190	3 38	250	4 47
15	0 17	75	1 26	135	2 35	195	3 44	255	4 53
20	0 23	80	1 32	140	2 40	200	3 49	260	4 58
25	0 29	85	1 37	145	2 46	205	3 55	265	5 4
30	0 34	90	1 43	150	2 52	210	4 1	270	5 10
35	0 40	95	1 49	155	2 58	215	4 7	275	5 16
40	0 46	100	1 55	160	3 3	220	4 13	280	5 21
45	0 52	105	2 1	165	3 9	225	4 18	285	5 27
50	0 57	110	2 6	170	3 15	230	4 24	290	5 33
55	1 3	115	2 12	175	3 21	235	4 30	295	5 39
60	1 9	120	2 18	180	3 26	240	4 36	300	5 44

† 1 minute of arc = 0·9 ft.

When a base line can be measured, this method of determining the distance will be found the most accurate: but there are many occasions where neither time nor the nature of the ground allow of this being done, and it is then that an instrument which will give the distance by one observation will be found useful.

I have been lately informed by Professor Smyth that an instrument to measure distances by double reflection and carrying its own base line was contrived by Dr Wollaston for one of the early Polar expeditions, the length of its base was 3 ft., and that a similar principle has been carried out in Russia, by M. Otto Struve, Director of the Great Central Imperial Observatory at Pulkova.

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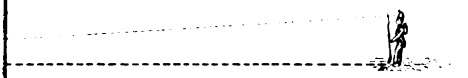
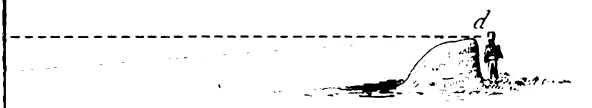
Plate I.

1.



2.



3.

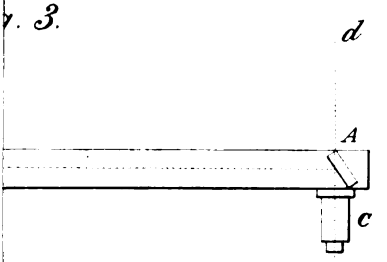


Fig. 6.

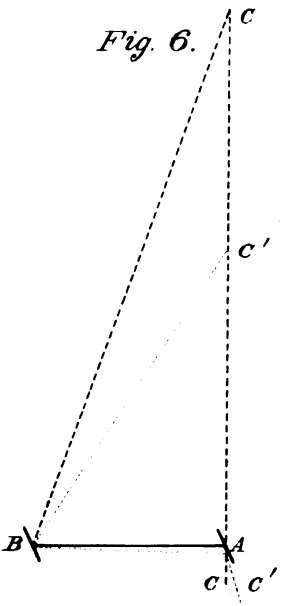
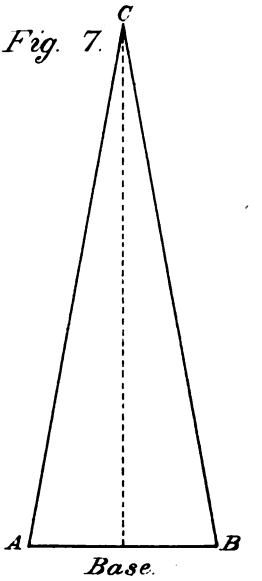


Fig. 7.



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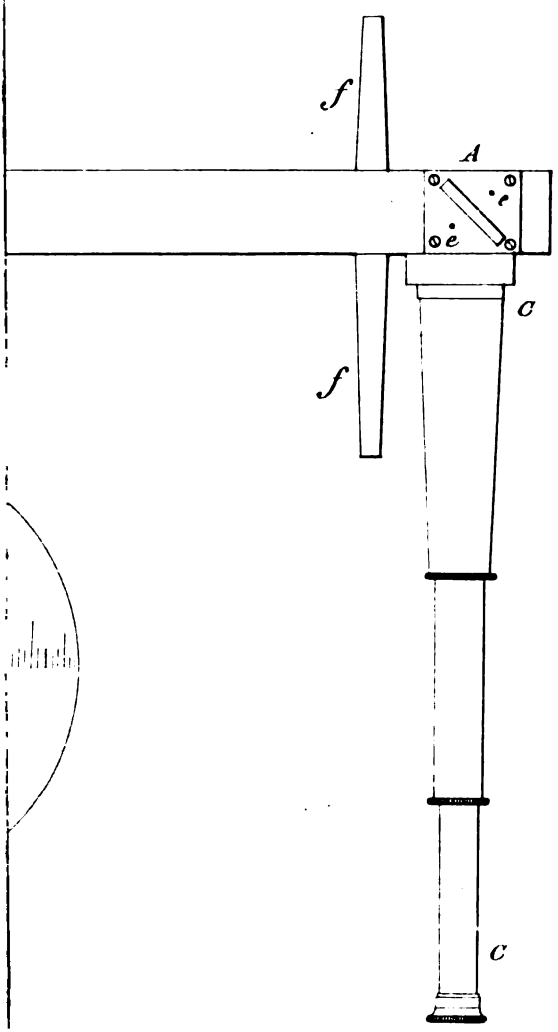

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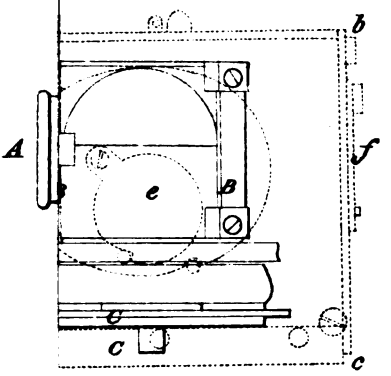
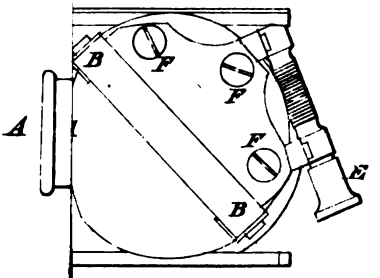
Plate III.





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Notes on the Early History of Artillery: by the late Colonel CLEAVELAND, R.A.

IN all wars before and after the conquest of England, it was the custom to use various sorts of instruments, engines, machines, spears, darts, javelins, bows and arrows, armour of iron for horsemen, footmen and charioteers, the care and provision of which in general, was committed to the Lieutenants of counties. The Master Bowyer, Master Fletcher, Master Carpenter, Master Smith, and other mechanics had patents and salaries from the Crown by way of retaining fees, and they were stiled OFFICERS OF THE ORDNANCE.

The monks appear in these ancient times to have been the conductors of such military defences as were then made use of in earth or masonry, and intrusted with money for paying the expenses.

Upon a governor being appointed to a garrison, fort, or castle, a special commission was issued under the Great Seal appointing commissioners to take an inventory or "remain" of all the implements of war. The governor then entered into articles of agreement with the state, covenanting, that in consideration of the armour, ammunition, victual, provision, officers, soldiers, gunners, and artificers, according to an inventory annexed to the indenture, and in further consideration of his being supplied with money to pay the garrison, he covenanted to "defend and keep the same for his Highness and the State, against all traitors and enemies whatsoever:"—See two trials in the reign of Richard II., quoted by Selden in *Privilege of Baronage of England*, fol. 17, where John Whiston and the Lord of Gomeniz were condemned to death for delivering up their castles.

The first record of cannon used in the field is in the reign of Henry III.

The first record of the exact number of persons retained in the ordnance, as well in time of peace as in war, appears in the reign of Edward III.

In the reign of Henry VIII. when the use of great ordnance became general all over Europe, England was famous for all sorts of workmen in the arts of manufacturing military weapons for the Tower of London. The Minories and adjacent places for a mile round were occupied as foundries, saltpetre houses, charcoal houses, sulphur houses, and shops for manufacturing all manner of warlike implements, fire arrows, fire darts, smoke balls, hand guns, harquebuses, which occasioned the employing a great number of mechanics in these abstruse branches: they took their abode chiefly in, and near the Tower, having patents and salaries from the crown as retaining fees.

1267. Henry III. In the rebellion by the Duke of Gloucester, his majesty king Henry III. approached London with his army making daily assaults, when guns and other ordnance were shot into the city.—GRAFTON'S *Chronicles*.

1322. Edw. II. His majesty Edward II. fought the battle of Leylade in Northumberland, where he lost his ordnance, which were conveyed into Scotland.—RASTELL'S, HOLINSHEAD'S, and GRAFTON'S *Chronicles*.

NOTE.—A few notes explanatory of ancient military terms have been added, but the text of the original MS. remains unaltered.

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Edw. III. 1327. In the first campaign of Edward III. against the Scotch, John Barbour the archdeacon of Aberdeen calls the English artillery "crakys of war," in his *Metrical Life of King Robert Bruce*, pp. 408, 9.[1]

1333. His majesty marches an army into Scotland, and besieges Berwick, which capitulated; he also gained the battle of Holydown Hill.

1338. His majesty with his army and artillery crossed over to Flanders intending to attack France.

His majesty's ships, "Edward" and "Christopher," taken by the French; in this action they used guns and bowes and arbalister shot.—GRAFTON'S *Chronicles*.

1339. His majesty commences his march towards France, passing the town of Brussels, to the siege of Cambray; after besieging it several days, his majesty from the lateness of the season, ordered it to be discontinued, and the army to immediately enter France.—GRAFTON.

1340. His majesty and army leave Ghent and besiege Tourney; after ten weeks assault, a truce was concluded, and the army with its great and small ordnance withdrawn to Ghent.

In the parliament held at Westminster, we find mention made of thirty-two tons of powder which was to have been furnished by one Thomas Brookhall.[2]

1342. The Scotch besiege the castle of Estrevelin with engines and cannon.—GRAFTON.

1343. His majesty with his army and artillery embark for France, and besiege Vannes.—GRAFTON.

1344. The number of persons of the ordnance retained by his majesty as well in time of peace as in war from the 18th to the 21st year of his reign, viz.:—

28 Masons.	24 Provisioners.
138 Carpenters.	60 Wargnores.
1 Cooper.	7 Armourers.
13 Smiths.	12 Artilleriens and gunners.
57 Engineers.	*Addl. MS.* 5758.

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[1] Twa novelties that day they saw,
That forouth in Scotland had been nane,
Timbers for helmes was the ane
That they brought then of great beautie,
And also wonder for to see;
The other crakys were of war,
That they before heard never air.

[2] The following is from Grose's *Military Antiquities*, Vol. I. p. 378.—"In the work called Cotton's *Abridgment of the Records of the Tower of London*, p. 24, there is a strange mistake respecting gunpowder; it being there said, that a pardon was directed to be made out 14 Edward III. to Thomas de Brookhall, for a debt of 32 tons of powder, and in the index it is added by way of note (before its pretended invention). The original in the rolls of Parliament stands thus:—'Item, pur Thomas de Brookhall, pur trent et deux toneux *de pomadre*, des quex il est chargé sur son acounte du temps qu'il estoit assigné de faire divers purveances a lœps le roi en la countée de Kent.' *Pomadre* is cider, instead of gunpowder, and probably provided for the king's drinking."

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1346. His majesty embarks with an army and artillery for Normandy, capturing Harfleure, Cherburgh, &c., marched into the county of Evreux which he burnt, except the walled towns and castles; the king not assaulting them in order to spare his people and artillery. He afterwards passed the city of Bexways without any assault given, because he would not trouble his people nor waste his artillery.—GRAFTON.

26 Aug. His majesty fought the battle of Cressy. Mezeray says that king Edward struck terror into the French army with five or six pieces of cannon, it being the first time they had seen such thundering machines.—RAPIN'S *History of England.*

1347. His majesty besieges Calais: he determined not to attack the town in order that he might spare his people and artillery, but famish them by a long siege. On the approach of the French king he fortified a castle between the town and the sea, "with springaldes,[1] bombardes, bowes, and other artillery;" he also secured his lines, by causing his navy to lie near the shore, every ship well filled with bombardes and other artillery. The following persons at the siege of Calais were paid by the ordnance,—masons, carpenters, smiths, engineers, tent-makers, miners, gunners armed and those that had the care of the artillery, numbering 314; some at one shilling, others at tenpence, sixpence, and threepence per diem.—RAPIN and GRAFTON.

1384. Rich. II. To John Walsh receiver of the king's provisions at Cherburgh, in money paid to him by John D'Arundell, marshal of England, late keeper of the castle and town of Cherburgh at the time he was discharged from the custody aforesaid for the undermentioned things, remaining there for the king's use for the defence and provision of the castle and town aforesaid, viz.—

For ten guns to throw stones, two of which are of iron and eight of other metal; seven of the said ten guns casting large stones 24 inches in circumference, and the three remaining casting large stones 15 inches in circumference; 200 lbs. of powder, 26 lbs. of saltpetre, and 24 lbs. of pure sulphur, were paid for at the exchequer in the account of the 17th day of June in the eighth year of our reign, &c.—Issues of the Exchequer by FREDERICK DEVON. See *Athenæum*, No. 503.

1386. Two French ships taken and brought into Sandwhich, on board was found a master-gunner, who led the English at Calais, also divers great guns and engines to beat down walls, also a great quantity of powder.—HOLINDSHEAD.

1398. His majesty with a great power and artillery embarked for Ireland and brought the greater part of that realm into good order.—GRAFTON.

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[1] *Springal.* An ancient military weapon for casting stones and arrows:—

"And sum that wente to the wal
With bowes and with springal."—*Beors of Hamtoun*, p. 159.

"Trybget,* springlas, and also engyne
They wrougt owre men full meckyl payne."—*Archeologia* XXI. 61.

* Trabucci.

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1400. Henry IV. His majesty with a great provision of men, munition, and artillery march into Wales, and drive the French out of that country.—GRAFTON.

1405. His majesty marched with his army into the north, and with his artillery besieged Berwick, the first shot overthrew part of one of the towers which caused them to surrender. The army afterwards proceeded to Wales.—HOLINDSHEAD.

1414. Henry V. Warrant from his majesty to Nicholas Merburg, master of the ordnance, and to John Louth his clerk, assigning the necessary workmen, and materials, with authority for pressing all sorts of carriages required for that service.—RYMER'S *Fœdera.*

1415. His majesty embarked at Southampton with his army and artillery, with boats covered with leather for crossing rivers, and landed at Havre de Grace.

He invested Harfleure, where his artillery was plied with such success that a considerable breach was made, which caused the enemy to capitulate; his majesty after repairing the bulwarks, walls, rampiers, and furnishing it with provisions and artillery, moved towards Pouthoise.

The following persons of the ordnance were present at the siege, viz.—

John Greyndon, Knight, with miners...		120
Gerald Van Willighen, Haynes Joye, Walter Stotmaker, Drovankesall Coykyer	master gunners with others	25
Each with two servoitour gunners		50

Nicholas Brampton, stuffer of bacynets[1]	
Armourers	12
Carpenters	124
Wheelers	6
John Benet, mason, with other labourers	120

25 Oct. His majesty fought the battle of Agincourt, wherein the above artillery were engaged.—NICOLAS'S *Agincourt,* 2nd Edit.

1417. A writ directed to John Louth, clerk of the ordnance, and John Benet of Maidstone, mason, reciting that a sufficient number of masons and labourers had been assigned for making seven thousand stone shot for guns of different sorts, with a sufficiency of stone for the same, as well in the quarries of Maidstone or elsewhere as should be most for the benefit of the service.

The workmen to be kept till the whole are complete, and men to be impressed for carting, boating, or other carriage of the said stones.—RYMER'S *Fœdera.*

July. His majesty with his army, artillery, and a thousand masons, carpenters, and other labourers, sailed from England and landed at Tongue in Normandy (retaining a few vessels for transporting his

9 Aug. artillery) which he besieged and became master of, 9th August.

9 Sept. Caen surrendered the 9th September, also several other towns and castles in this year.—HOLINDSHEAD and RAPIN.

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[1] *Bacinets* were light helmets, so called from their resemblance to a bason, and were generally without vizors. Bacinets (or bassinets were worn in the reigns of Edward II. and III. and Richard II. by most of the English infantry, as may be repeatedly seen in the Rolls of Parliament and other public records."—GROSE.

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1418. His majesty who had commenced his campaign in August of the previous year, and which lasted the whole winter, without interruption or respite, finished with besieging the town and castle of Falaise the 1st December.

16 Feb. Falaise surrenders.

March. April. In the months of March and April he possessed himself of St Lo, Carentan, St Sauveur le Velcomte, and many other towns in Normandy.

May Evreux surrenders.

August. Cherbourg surrenders after a siege of three months.

Sept. Rouen the last remaining fortress in Normandy belonging to the King of France, besieged, and capitulated after five months.

1419.
19th Jan. Rouen surrenders.
Normandy brought into the king's subjection.

1420 to 1425. Henry VI. The army continued in Normandy, occupying the several fortresses, and capturing others, which the artillery were conspicuous in firing great stones out of great guns against their walls, his majesty fortifying the same with men, ordnance and artillery.—HOLINDSHEAD and GRAFTON.

The English defending the town of St James de Leitson on the frontiers of Normandy, issued out attacking the besiegers, and capturing 14 great guns and 40 barrels of powder.—GRAFTON.

1428. The earl of Salisbury besieges Orleans, which he encompassed with forts to the number of sixty, of these six were considerably stronger than the rest commanding the principal avenues to the city, and in which he placed his cannon.

When the besieged perceived that they were environed with fortresses and ordnance, they laid gun against gun, and fortified towers against bulwarks, and within made new rampiers, and built mud walls to avoid cracks and breaches, which might by violent shot suddenly ensue.—GRAFTON and RAPIN.

1433. The earl of Arundel wounded by a shot from a culverin in his attack of the castle of Gerborye, of which hurt he shortly died.—GRAFTON.

Item for his (Duke of Somerset's) shipping and his ordnance.

"Be there made a privy seal to Gilbert Parr, master of the king's "ordnance, to deliver to John Downson, master of the ordnance of my "Lord of Somerset, 4000 lbs. of saltpetre, 3000 sulphur, 3000 bowes, "3000 sheaves of arrows, 200 gross of strings, &c."—NICOLAS's *Privy Council Proceedings*, Vol. V.

1449. The Duke of Somerset, the king's lieutenant in France, acquaints the king and council, that he required both ordnance and artillery for the defence of Normandy in case of its being attacked.

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1455. Thomas Vaughan, Esq., the then master of the ordnance, presented a petition to His Majesty stating, "That for as muche as ther is noow housing certaynly assigned for your ordenaunce to be kept, for lak whereof ther hath growe grete hurt and dayly doth unto the said ordenaunce and other stuffe longing to his said Office." And in consideration thereof he prayed His Majesty to grant for its use "All the grounde and soille called ye Tour Wharf," from the Watergate of the Tower now called the Traitor's Gate, unto the Gate of St Catherine's, together with "all maner of howsing, and other appurtenaunces sette uppon the same," which was accordingly granted under the royal signature.—BAYLEY'S *History of the Tower of London.*

1456. Commission to John Judd as master-general of the ordnance. *Excepta Historica*, p. 10.

1471. Edw. IV. King Edward IV. landing at Ravenspur in Yorkshire, brought over and introduced hand-guns or muskets. In his battles with the Earl of Warwick, both armies were furnished with great artillery.—HOLINDSHEAD.

1474. 4 July The king embarks for France with a large army and artillery, with artificers and labourers.—HOLINDSHEAD.

1482. The king collected his army and prepared his artillery to invade Scotland, a thousand men of the army were appointed to give their attendance on the ordnance. The whole embark under the Duke of Glocester, and arrive at Berwick, which they besiege and capture the 24th Aug. The Duke placed a garrison of Englishmen, and artillery sufficient to defend it against all Scotland for six months.—HOLINDSHEAD.

1483. Feb. 26. A warrant to the constable of the Tower to deliver to Roger Beckley eight surpentines upon carts, 28 hackbushes with their frames, one barrel of touch powder, two barrels of serpentine powder, &c.

Edw. V. 16 June. A warrant for delivering unto Thomas Tunstall, two serpentines, two guns to lie upon walls, twelve hackbushes, two barrels of gunpowder, &c.

Rich. III. Raufe Bygood was appointed to the mastership of the ordnance during life with a hundred marks fee for himself, and the wages of sixpence per diem for a clerk, and sixpence for a yeoman. John Stoke the office of clerk of the ordnance within England or elsewhere for the time of his life, with wages of sixpence per diem. Richard Warrington the office of the artillery within the town of Calais with wages of one shilling per diem, and sixpence for a yeoman under him for life. To Patrick de le Mayte, gunner, the office of master-gunner within the Tower of London, to Henry Grey the younger, squire, a confirmation of the office of the keeping of the armoury within the Tower of London. To Theobald Ferrount, gunner, an annuity of £12. To William Tempell the office of yeoman of the ordnance.—*Harl. MS.* No. 433, pp. 31, 52, 105, 157, 178.

Hen. VII. 1485. Sir Richard Gilsford appointed master of the ordnance.—GROSE'S *Military Antiquities.*

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1491. Sir Edward Poinings with bold soldiers and sufficient artillery, embark for Flanders and besiege Sluis, which capitulated.

6 Oct. The king embarks with his army and artillery for Calais and besieges Boulogne. After breaking the walls and sore defacing them with his battering pieces, peace was concluded between them.—HOLINSHEAD.

1496. His majesty marches with a populous army, and plenty of artillery, out of the city for the attack of the Cornish rebels on Blackheath whom he defeated.—HOLINSHEAD.

1497. The Earl of Surrey with an army and artillery march into Scotland in pursuit of the Scotch army, he besieges Haiton Castle which surrendered in a few hours. The Earl caused his miners to raise and overthrow the fortress to the plain ground.—HOLINDSHEAD.

1498. In this year all the gardens which had been continued out of mind, without Moorgate of London, were destroyed, and of them was made a plain field for archers to shoot in.—HOLINDSHEAD.

Hen. VIII. James king of Scotland about this time gave liberal possessions to Robert Borthwick, a notable artificer for making of field pieces and other guns; for which liberalities he should make certain great pieces in his castle of Edinburgh, whereof there are many yet to be seen in Scotland with this superscription,

"Machena sum Scoto Borthwick faboricata Roberto."

HOLINDSHEAD, Vol. v. p. 470.

1511. Sir Thomas Darcy with 1500 archers and others on an expedition to Spain.

Sir Edward Poinings, knight, with 1500 archers and artillery, commanded by Thomas Hart, governor or chief gunner, embarked on an expedition to Flanders, to assist the Lady Margaret, Duchess of Savoy. They besieged and won the castle of Brimnoist, and took possession of the town of Aiske.—HOLINDSHEAD.

1512. Thomas Grey, Marquis of Dorset, embarked with an army and artillery for Spain, they landed at Passage on the coast of Briskey; Sir John Stiles ordered 200 mules to be purchased for the artillery, and prepared for attacking the French in Gascoyne.—HOLINDSHEAD.

1513. Sir Sampson Norton appointed master of the ordnance.

21 July. King Henry with an army, and the master of the ordnance, with the king's artillery, as fauchons, slings, bombardes, carts with powder, stones, bowes, arrows, &c. The whole number of carriages 1300, the leaders and drivers of the same 1900 men, marched from Calais for the siege of Terouenne. On the march, by the negligence of the carters, a great curtall[1] (called the John Evangelist) was overthrown into a pond of water,

[1] The piece of ordnance called a "curtall" is seldom mentioned by the early writers on arms and armour, and it is therefore difficult to ascertain the nature of the gun, though from the similarity of the word to that used to signify "a horse or a dog whose tail has been very closely cut," it may be inferred that the piece of ordnance was one of those which like the *bastard* and *minion* differed in dimensions from the "ordinary" gun of the period. The "curtall" is mentioned by Hall in his Chronicle of Henry VIII.

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also a bombarde of iron (called the Red Gun) overthrown in a lane. The first gun was captured by the French and carried into Boulogne, the other was recovered by the Lord Barnes, captain of the pioneers and labourers, protected by the Earl of Essex and his company.

On the 4th August his majesty arrived before Terouenne, enclosing his camp with artillery, as fauchons, serpentines, cast hackbushes, and tried harrows, &c., and with his great ordnance did sore beat the walls; and Sir Alexander Buinam, a captain of miners, caused a mine to be enterprised to enter into the town.

16 Aug. Battle of Spurs. On the 16th the master of the ordnance threw five bridges across the river, over which the army and great ordnance passed, and attacked with success the French army, when the English artillery (culverins) came into play. The batteries having breached the

18 Aug. walls in several places, Terouenne surrendered the 18th. The walls and fortifications were razed, the town burned and the ordnance sent to Aire for the king's use.

23 Aug. His majesty marched to invest Tournay, the siege commenced the 23rd with 21 pieces of great artillery, and surrendered the 29th.

1513. Sept. The Earl of Surrey collects his forces at Alnwicke, Sir Nicolas Appleyard, master of the ordnance; they march towards the Scotch army, and on the 9th gained the battle of Flodden, wherein King James was killed. The next day a Scotch force appearing in the field, William Blackenall, who had the chief rule of the British ordnance caused such a peal to be shot off at them that the Scots fled. Two and twenty pieces of ordnance were taken, amongst them seven culverins of large assize, called by King James, the "Seven Sisters".[1]—HOLINDSHEAD.

The master gunner of the English part opened his fire, slew the master gunner of Scotland, and beat all his men from their ordnance, so that the Scotch ordnance did no harm to the English, but the English artillery shot into the midst of the king's battle, and slew many persons.[2]

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1 "They saw, slow rolling on the plain
Full many a baggage cart and wain,
And dire artillery's clumsy car
By sluggish oxen tugged to war.
And there were Borthwick's sisters seven,
And culverins which France had given.
Ill omen'd gift! the guns remain
The conqueror's spoil on Flodden's plain."
Marmion, Canto IV. Division 27.

2 The following extract will give an idea of the value of pieces of artillery at this period:—"The king* went in person against it,† and for its reduction borrowed from the castle of Dunbar, then belonging to the Duke of Albany, two great cannons, whose names were 'Thracon mouthed Mow and her Marrow,' also 'two great botcards and two moyans, two double-falcons, and four quarter-falcons,' for the safe guiding and re-delivery of which, three lords were laid in pawn at Dunbar."—*Marmion*, Note 15 to Canto 5.

* James V. † Tantallon Castle.

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1516. His majesty ordered 1200 masons, and carpenters, and 300 labourers to the city of Tournay.

1519. Sir Edward Gilford, master of the armoury.—HOLINDSHEAD.

1521. Great brass cannon and culverins first cast in England by John Owen.—STOWE.

1523, 6 July. The Earl of Surrey with an army, and artillery commanded by the master of the king's ordnance, Sir William Skevington, having landed the Emperor in Biscay, returned with his fleet and made a descent on the coast of France, near Morlies, marching thither and assaulting the town won it, for the master gunner, Christopher Morris, having there certain falcons, with the shot of one of them struck the lock of the wicket in the gate, so that it flew open, and then the same Christopher Morris and other gentlemen with their soldiers in the smoke of the guns pressed to the gates, and finding the wicket open entered, and so finally was the town of Morlies won and put to sack. The army shortly after returned to England.—HOLINDSHEAD.

23 Aug. Admiral Sir William Fitzwilliam with his fleet, soldiers, and field artillery, under the master-gunner, Christopher Morris, sail for the French coast, land near Trayport, after severe fighting they re-embark after burning seven fine ships, destroying their bulwarks, and capturing twenty-seven pieces of ordnance.

1524. His majesty directed an army under the Duke of Suffolk with two thousand six hundred labourers and pioneers to be transported to Calais, the first enterprise was the winning the castle, called Bell Castle, by the Lord Sands and the Lord Ferrers, who did so much by the power of battery that they surrendered, and Sir William Skevington was directed to raze it down to the ground.

26 Oct. They afterwards besieged Bray, which was carried by assault the 20th October, after five hours battering with their ordnance.

27 Oct. Sir William Skevington opened his batteries against Mondedier with such force that after four hours battering the walls were overthrown and made assaultable, when the garrison surrendered.

13 Nov. The Duke assaulted and carried Boghan Castle, wherein were found 76 pieces of artillery, as bombardes, curtaux, and demi-curtaux, slings, cannon, volgers, and other ordnance. The army returned to Calais leaving his great ordnance at Valencenes.—HOLINDSHEAD.

1526. Peace concluded with the French.

1530. The Irish spoil and burn the county of Kildare, his majesty sent the Earl of Kildare to Ireland with Sir William Skevington, master of the king's ordnance, and divers gunners with him, which so politically ordered themselves that the enemies were glad to offer amend, and Sir William Skevington the next year returned to England, leaving the Earl of Kildare for the king's deputy.—HOLINDSHEAD.

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1532. The master of the king's ordnance lodged in the "Bryck Tower," of the Tower of London, also the Ordnance Office in the same.—BAYLEY'S, *History of the Tower.*

1537. To the many laws, ordinances, and regulations issued for the support of archery, may be added the institution of the Artillery Company, which was incorporated by the Patent of Henry VIII. in the year 1537, to Sir Christopher Morris, knight, master of the ordnance, Anthony Knevet and Peter Mewtes, gentlemen of the Privy Chamber, overseers of the fraternity or guild of St George, granting licence to them to be overseers of the science of artillery, viz. for long bows, cross bows, and hand guns; and the said Sir Christopher Morris, Cornelys Johnson, Anthony Anthony, and Henry Johnson, to be masters and rulers of the said science of artillery during their lives, &c.

Sir Christopher Morris appointed master of the ordnance.—GROSE'S *Military Antiquities.*

1543. The first pieces of *iron*, both cannon and mortars, ever made in England, were manufactured at Buckstead in Sussex, by Peter Baud, Ralph Hoge, and Peter Van Colin.—STOWE.

1544. 4 May. The Earl of Hertford with an army (and artillery commanded by Sir Christopher Morris, master of the ordnance), embarked for Scotland, landing near Leith, which town they immediately captured. On the 6th the army marched towards Edinburgh, when Sir Christopher Morris with his gunners and ordnance, beat the Scots from their ordnance, and opened the Canongate with the shot of their great ordnance.—HOLINDSHEAD.

His majesty's warrant to Sir Thomas Seymour, master of the ordnance to provide ordnance, carriages, ammunition, and habiliments of war, with officers, their servants, conductors, gunners, wagoners, pioneers, carpenters, bowyers, fletchers, and other artificers, with the freight to accompany the army in France.

	per diem. £	s.	d.
Sir Thomas Seymour, master of the ordnance	1	6	8
do. conduct money at 4d. per mile			
do. coat money for 20 servants at 4d. each.			
A horse tent.			
Sir Thomas Darcie, master of the armoury	1	0	0
Sir Christopher Morris, knight, lieut. of the ordnance	0	10	0
A clerk for him, Robert Morgan	0	2	0
6 servants, each	0	0	6
Burnardyne de Vallowayes, John Bassett } master gunners each	0	4	0
209 gunners, each	0	0	7
157 artificers, each	0	0	8
John Cookson, chief conductor of the train	0	6	0
A clerk to him	0	2	0

	per diem. £	s.	d.
John Verney, overseer of the king's great mares for the train of artillery	0	4	0
William Heywood, assistant to him	0	1	0
Thomas Mulberry, Harry Hughes } guides of the said mares, each	0	1	0
6 conductors of the ordnance.			
20 carters, each	0	0	6
William Reyherne, captain of the pioneers	0	4	0
100 pioneers, each	0	0	8
John Rogers of the privy ordnance and weapons.			
15 gunners appointed to the brass pieces about the king's tent.			
55 gunners appointed to the shrympes with two cases each.			
4 carpenters.			
4 wheelers.			
3 armourers.			

Charles Walman, an officer employed to choose the gunpowder.

The pioneers received two shillings a piece transport money from Boulogne to Dover, and conduct money from Dover to their dwelling places; 4*d.* a mile for the captain, and ½*d.* for every pioneer.—*Harl. MS.* 5753.

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14 July. His majesty with an army passed over to the siege of Boulogne, where Sir Christopher Morris, master of the ordnance, with his great artillery and mortar pieces so battered the walls from three several places, that there were very few houses left; the breaches being practicable, the assault was made by the Lord Admiral Dudley, under the protection of the artillery, which kept up a continual fire on the breach during their advance. After a severe conflict the assailants were recalled, shortly after which the governor capitulated.

Sir Christopher Morris was hurt by a hand-gun at the siege.—HOLINDSHEAD and RHYMER.

1545. 14 Feb. The Earl of Hertford informs the Lord Cobham that the ordnance is arrived, but the stock of the demi-cannon is broken, and that therefore he sends Wenlock, the master-gunner of Boulogne, to choose such another as he shall think meet.—*Harl. MS.* 284.

20 July. His majesty's fleet sailed out of Portsmouth harbour to attack the French at St Helens. (One of the fleet the "Mary Rose" was drowned in the midst of the haven by reason she was overladen with ordnance, and had the ports left open, which were very low, and the great artillery unbreeched, so that when the ship should turn, the water entered and suddenly she sank. In her was Sir George Carew, knight, and 400 soldiers under his guiding; only 40 escaped. Several of the guns were raised in the year 1835-6 and brought to the Arsenal at Woolwich).

1546. The Earl of Surrey writes over to the king's council, that the French had cast much larger cannon than had yet been seen, with which they imagined they should demolish Boulogne.

The Earl of Hertford with an army and artillery, Sir Thomas Wiat, master of the ordnance, were sent over to Calais.—HOLINDSHEAD.

1547. Edw. VI. Allowances to officers and ministers of the ordnance in Edward VI. reign.

per annum.	£	s.	d.
The master of the ordnance, fee	151	6	8
The lieutenant	100	10	0
Surveyor	36	10	0
Clerk	38	8	0
Yeoman	27	7	6
per diem.			
Master-gunner	0	1	0
Gun stone maker	0	0	6

per diem.	£	s.	d.
Saltpetre maker	0	0	6
Gunfounderer	0	1	4
Gunsmith	0	0	6
Artificers, each	0	0	4
10 master overseers, each	0	0	8
68 gunners: 20, each at	0	1	0
12 "	0	0	8
24 "	0	0	6
2 "	0	0	4

Besides gunners in the several forts and castles in England.—*Harl. MS.* 240.

Sir Francis Flemynge, knight, appointed master of the ordnance.—HOLINDSHEAD and GROSE.

10 Sept. The Duke of Somerset marched into Scotland, gained a complete victory at Musselburgh, taking eighty pieces of cannon in his short expedition. Sir Francis Flemynge, master of the ordnance, with 15 pieces of great ordnance, and other pieces; John Man, treasurer of the ordnance, Sir Richard Leigh, knight, deviser of the fortifications,

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—Cornelius comptroller of the ordnance, John Brenne with 1400 pioneers accompanied the artillery with the army.—HOLINDSHEAD.

1548. Sir Phillip Hoby, appointed master of the ordnance.

English artillery in the reign of Edward VI., and about the year 1548, consisted of

			£	s.	d.	£	s.	d.
1 master of artillery.....	Sir John Hoby .....(fee)	.....	0	0	0	151	11	8
1 lieutenant.....	Sir Francis Fleming	„	0	0	0	66	13	4
1 surveyor	Anthony Anthony...	„	0	0	0	36	10	4
1 clerk.....	John Rogers	„	0	0	0	12	3	4
	In room of servants		0	0	0	12	3	4
1 yeoman	Thomas Sheventon...	„	0	0	0	9	2	6
	In room of servants		0	0	0	18	5	0
1 master-gunner	Christopher Gold ...	„	0	1	0	18	5	0
1 gun stock maker	Symond Fernes	„	0	0	0	9	2	6
2 gun founders	John Owen	„	0	0	8	12	3	4
	Thomas Ogey	„	0	0	0	12	3	4
1 gunsmith	John Anthony	„	0	0	6	9	2	6
1 artificer or engineer ...	John Pudney.....	„	0	0	4	6	1	8
1 master carpenter	John Johnson.....	„	0	0	8	12	3	4
	15 at 12d. a day each		0	15	0	273	15	0
	12 at 8d. „ „		0	8	0	146	0	0
109 gunners whereof.....	80 at 6d. „ „		2	0	0	730	0	0
	2 at 4d. „ „		0	0	8	12	3	4
	Total charge of the Artillery for one year					£1547	9	2

In the 109 gunners above mentioned are included fees to the following persons, viz.:—

To the clerk John Rogers .....at 8d. a day.
„ master-gunner.....at 12d. „
To the yeoman.....at 12d. a day.
To John Owen, gun founder, at 12d. „

So that 105 effective gunners remain.

These two last accounts are taken from a manuscript of the Rev. W. Gostling's and very obligingly communicated by Capt. W. Gostling of the Royal Artillery.

Capt. G. SMITH, Inspector of the
Royal Military Academy at Woolwich.

Military Dictionary 4th, 1779.

15 Jan. Sir Philip Hoby writes to the Duke of Somerset from Brussels, desiring that due care may be taken of the office of the ordnance, which was incorporated by king Henry VIII., and not since confirmed which, with the non-payment of their debts, has brought them into decay.—*Harl. MS.* 623.

An order in council to fortify Lowder in Scotland. Sir Thomas Palmer and Sir Thomas Holcroft were appointed to go thither with a convenient number of men of war and pioneers to see that town fenced with trenches, rampiers, and bulwarks.—HOLINDSHEAD.

1549. 4 Oct. The Lord Protector and Council to the Lord Cobham, Deputy of Calais, desiring him to send speedily 20 of the ablest gunners, which were at Newhaven, and now remain in Calais, by sea to the Lord Clinton at Boulogne.—*Harl. MS.* 284.

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The Earl of Warwick, with an army and artillery, is ordered against the Norfolk rebels, whom he overcomes after hard fighting.—HOLINDSHEAD.

The Earl of Rutland ordered to raise the fortifications of Hadington, and remove the ordnance to Berwick.—HOLINDSHEAD.

1552. 30 April. Through the negligence of the gunpowder makers, a certain house near the Tower of London, with three carts of powder was blown up and burnt with 15 gunpowder makers.—HOLINDSHEAD.

Queen Mary 1553. Sir Edward Brair appointed master of the ordnance.

Sir Edward Brair with certain field pieces encountered the rebels at Charing-cross.—GROSE and HOLINDSHEAD.

1555. Sir Richard Southwell, master of the ordnance and armoury.—HOLINDSHEAD.

1557. An army with artillery embarked under the Earl of Pembroke for the Netherlands, and joined the Spanish army, commanded by the Duke of Savoy. The Lord Robert Dudley, Earl of Leicester, master of the ordnance, and Sir Richard Leigh, trench master, Edward Chamberlain, captain of the pioneers.—HOLINDSHEAD.

Establishment of the artillery for the above expedition, who with the Lord Robert Dudley were present at the siege and capture of St Quintins.

	per diem. £	s.	d.
The master of the ordnance	1	6	8
His lieutenant	0	13	4
Master of the carriages	0	10	0
The trench master	0	5	0
A chaplain	0	1	0
A clerk of the ordnance	0	2	0
2 clerks	0	2	0
A surgeon	0	1	0
6 boweyers	0	6	0
6 fletchers	0	6	0
3 carpenters	0	3	0

	per diem. £	s.	d.
3 smiths	0	3	0
3 guides of the ordnance	0	4	0
12 carriages	3	0	0
A drum	0	1	0
A fife	0	1	0
120 smiths	1	5	0
10 halberdyers	0	10	0
Harquebutters on horseback for the lieutenant	0	6	0
Master-gunner	0	3	4
12 gunners	0	16	0

Harl. MS. 6844.

1558. John Hiefield, master of the ordnance, was sent from Calais to give due advertisement of the French king's intention of attacking Calais, and to have a supply of things necessary for mounting of the great artillery, whereof he had charge; he was made prisoner on its capitulation. Master-gunner Horslie in the defence of Newnam Bridge, lost his head by the first shot from the French batteries.—HOLINDSHEAD.

Sir William Pelham appointed master of the ordnance.—GROSE's *Military Antiquities.*

1559. Queen Elizabeth, Ambrose Dudley, Earl of Warwick, appointed master of the ordnance.

Mr Gower, master of the ordnance in the northern parts of England under the Lord Grey of Wilton.

John Owrde, gentleman, master of the ordnance at Berwick with pay, per annum			20	0 0
40 gunners paid.	10 gunners	per annum, each	9	2 6
	22 do		9	0 0
	8 do		6	8 4

From *State Papers* of Sir Ralph Sadler.

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3 Oct. Sir Ralph Sadler, and Sir James Croft to the Lords of the Privy Council.

"It may like your good lordships to understand, that whereas our late Sovereign Lady, Queen Mary, in her time addressed her letters to the Earl of Westmoreland, then her highness lieutenant here, that he should take order for the allowance of two pounds of corn powder every month, to be given to every harquebutier in these bands, of her gracious liberality and reward, to the intent they might by the use and exercise of their pieces learn to be more profit in that feat. Whereupon the said Lord Lieutenant wrote his letters to Mr Gower, then master of the ordnance in these north parts, willing him to make the said allowance by the warrant of Sir John Brende, then muster-master here, from time to time, which was performed accordingly untill the 1st of May last past; since which time the said Gower hath no further warrant; notwithstanding that, ever since unto this present the soldiers have had their powder as they had before of the Queen's Majesty Store, thinking to enjoy still their foresaid allowance. There is now a question risen thereof betwixt the said Gower and the captains and soldiers here of the said bands, for that the said Gower requireth to stop so much money in the treasurer's hands of their pay as would satisfy for the powder which they have had of him since the said 1st of May; and on the other side the said captains and soldiers do allege, that they knew none other but that they should still enjoy their said allowance, because they had no sufficient warning to the contrary, or else the poor soldiers would not have spent so much powder as they have done, which if they should now be compelled to pay for, should be to their great hinderance.

"The said Gower sayeth he gave them warning thereof, and they deny it, so that hereof ariseth the controversey. Wherefore we are become humble suitors to your Lordships that it may please you to have some consideration of the same; and though we think that it had been much better to have relieved the soldiers some other way, because we like not the president, yet since it is past, and that thereby the harquibutiers here are become so perfect in their feate, that for so many we think there be no better of no nation, We humbly beseach your good lordships, that it may please you to direct your letters unto the said Gower, for his better warrant to make the said allowance till this present, and from hence fourth it may cease, whereby though the Queen's Majesty be the loser, yet the controversey would be ended, and the captains and soldiers here well contented."

16 Dec. Mr Secretary Cecill to Sir Ralph Sadler and Sir James Crofts.

"It is wished we should take possession of the Fryth for our greater succor, and that Lord Grey should do this exploit, and have, besides the footmen, 600 horsemen with lances and pistolets, and 14 or 1500 light horsemen, and five or six good brass pieces for battery."

22 Dec. Sir Ralph Sadler recommended to Mr Secretary Cecill that a larger proportion of ordnance should be sent with Lord Grey.

1560. Thomas Gower, master of the English ordnance present with the army in the attack of the French at Leith.

Pay of the gunners of the great ordnance at Berwick.

	per diem. s.	d.		per diem. s.	d.
1 master-gunner at	4	0	4 quarter-masters, each	1	4
His mate „	2	0	44 gunners..... „	1	0

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At Carlisle.

10 gunners at per diem, each 8*d.*

At Worke Castle.

	s.	*d.*		*s.*	*d.*
1 master gunner at per diem	1	0	His mate at per diem	0	10

2 gunners, at per diem each 9*d.*

In the North.

Thomas Gower, master of the ordnance	6	8	John Flemynge, master-gunner	3	4
John Bennet, master of the ordnance, his clerk and his men ...	12	4	His mate	1	8
			4 quarter-masters, each	1	0
			44 gunners, each	0	10

William Bromfield, lieutenant of the ordnance.—*Harl. MS.* 5752.

1561. Queen Elizabeth ordered Berwick to be well fortified, and directed many brass cannon to be cast, and encouraged the making gunpowder.

The Earl of Warwick lands with his army at Newhaven in Normandy.

1562. William Bromfield sworn master of the ordnance (under the Earl of Warwick, captain-general of the English forces in Normandy), killed in the defence of Newhaven in 1563.

Sir John Portinarie sent from England as chief engineer under the Earl.

The Earl of Warwick wounded.

1565. Robert Thomas, master-gunner of England, killed by a piece of one of the chambers, when attending the firing a salute at the marriage of the Earl of Warwick, general of the ordnance.

1566. Edward Randall, Esq., lieutenant of the ordnance sent into Ireland, where he lost his life in an engagement with the Irish.—HOLINDSHEAD.

1569. Humfry Barwicke, master of the ordnance at Berwick.

Accounts rendered by Sir Ralph Sadler, treasurer to her majesty touching the great ordnance, viz,—

	per diem. £	*s.*	*d.*
Humfry Barwicke, master of the ordnance for the field, for his own entertainment at	0	10	0
3 light horsemen attending upon the ordnance, each	0	1	4
3 footmen attending upon carriages, do	0	0	8
1 clerk	0	2	0
1 master-gunner	0	2	0
1 mate	0	1	0
2 gunners	0	0	8
1 master-carpenter and his man	0	1	8
1 master-smith, 1 wheeler, each	0	1	0
2 men ..... „	0	0	8
4 carpenters ..... „	0	0	10
8 do ..... „	0	0	8
Humfry Barwicke, captain of pioneers	0	4	0
100 pioneers, each	0	0	6
Humfry Barwicke for sundry charges touching the said great ordnance, as by a book of the parcels doth appear, paid by warrant of the said lord lieutenant, dated 29 January, 1569 (70) annexed to the said book together with his acquit.			
The same Humfry Barwicke by warrant, dated 3rd December, 1569, for conveyance by water of armour, and ammunition from Kingston-upon-Hull to York, viz. to the master of the "Keale" 72*s.*, and the marrinors for their charges	4	9	4

John Wildinge, master boweyer of ordnance in the north parts, for the charges of bringing by ship of certain armour and ammunition from Newcastle unto Kingston-upon-Hull, and returning back by warrant, dated 3rd December, 1569.

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1570. The Earl of Sussex, lord lieutenant, with an army and artillery, both field and battering train, marched from Berwick into Scotland, destroying several towns and castles.

1572. 16 Feb. A warrant from her majesty to the Earl of Warwick, master of the ordnance, to send from the Tower 50 carts of cornpowder and 5 carts of serpentine powder to Thomas Sutton, master of the ordnance at Berwick.—*Addl. MS.* 5754.

Mar. 25. An order in council for choosing gunners out of the most likely and active persons belonging to the several trades in London, who were trained up in warlike feats, mustered three times a week, sometimes in the artillery yard, teaching them to handle their pieces, sometimes at the Mile's End, and in St George's Field.—HOLINDSHEAD.

1573. 28 July. A warrant from her majesty to the Earl of Warwick, master of the ordnance, to send powder and stores to Jacques Wingfield, Esq., master of the ordnance in Ireland.

1575–1577. Similar warrants to the above.—*Addl. MS.* 5754.

1574. The names of our great ordnance are commonly these.

NAMES.	Weight.	Diameter.	Weight of shot.	Scores of carriage.	Charge of powder.	Height of bullet.
	lbs.	inches.	lbs.		lbs.	inches.
1 Robinet	200	1¼	1	...	½	1
2 Falconet	500	2	2	14	2	1¼
3 Falcon	800	2½	2½	16	2½	2¼
4 Minion	1100	3¼	4½	17	4½	3
5 Sacre	1500	3½	5	18	5	3¼
6 Demi-Culverin	3000	4½	9	20	9	4
7 Culverin	4000	5½	18	25	18	5¼
8 Demi-Cannon	6000	6½	30	38	28	6½
9 Cannon	7000	8	60	20	44	7¾
10 E Cannon	8000	7	42	20	20	6¾
11 Basiliske	9000	8¾	60	21	60	8¼

1578. From Grose's *Military Antiquities*, Vol. I. p. 198, was taken the duties of the master of the ordnance in the field, as obtained from an ancient manuscript of this date:—

"First, it is the office of the master of the ordnance, after that he hath received his charge at the councel's hands, he must first of all, in anywise before he shall go fourth to the camp, see that they lack no kind of ammunition, or such other necessaries which appertain to the said master of the ordnance.

"And there are appertaining to the master of the ordnance a lieutenant, and certain clerks which are all on wages.

"Also the said master of the ordnance must also receive the ordnance, shot, cornpowder, serpentine powder, match, and all other ammunition, as fire works, bows, arrows, strings, pikes, bills, halberts, harquebusses, lances, light horsemens staves, javelins, and bore spears.

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"And further, the said master of the ordnance must receive all kinds of necessaries, that is to say, ladders, ladles and sponges for artillery; mattocks, spades, shovels, pickaxes, crows of iron, cart wheels for ordnance, carriages for ordnance, axletrees, hand axes, axletrees for ordnance, windons[1] for the defence of ordnance, cart traces, with all kind of cart wares, as ropes, cressets[2] and cressettes, lights, lanthorns, candle and links, with all other necessaries which must be foreseen, that there be no lack before their going on.

"Further, it is the office of the master of the ordnance, after he comes into camp, and the provost-marshall hath appointed the ground most mete and necessary for the artillery, then must the aforesaid master of the ordnance cause the said ordnance to be brought to the said place appointed, there to be placed to the most advantage.

"*Item.*—The said master of the ordnance must cause the said ammunition to be brought to the place appointed, and mete therefore, which must be trenched about, for the danger of fire; and the aforesaid master of the ordnance must charge some discreet man with the watch if it stands in need.

"Also the said master of the ordnance must see that there be attending on the office of ordnance certain artificers, as carpenters, wheelwrights, smiths, boweyers, fletchers, masons, and such other necessary men, mete and convenient therefore.

"The said master of the ordnance his office is, that if there be any captain that lacketh ammunition for his soldiers, the said captain shall come to the master of the ordnance, and he must command the clerk of the ordnance to deliver such ammunition as he lacketh; providing always that the clerk of the ordnance do take a bill of the captain's hand, or of his lieutenant for the said ammunition, and at the pay day the clerk shall deliver the said bills unto the treasurer, that he may stay so much money in his hands as shall answer the Queen for the ammunition so delivered.

"Furthermore, it is the office of the master of the ordnance that if the enemy and you join battle, the ground being appointed by the officer of the field, where the battle shall be pitched, to repair to the field, there to see the

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[1] *Windon.* From the context it is evident that the *windon* was what is now called a "chevaux-de-frise." The word has a great similarity to the word "windle," which in Lancashire signifies a machine or wheel on which yarn is wound, and which much resembles the modern chevaux-de-frise.

[2] "*Cresset.* An open lamp, suspended on pivots on a kind of fork, and carried upon a pole, formerly much used in nocturnal processions. The light was a wreathed rope smeared with pitch or rosin, stuck on a pin in the centre of the bowl. The cresset was sometimes a hollow pan filled with combustibles, and indeed, any hollow vessel employed for holding a light was so called."—*Dictionary of Archaic and Provincial words.*

"The *cresset-light* was set upon beacons and watch towers, or carried upon a pole. It was a square or circular framework of iron, having open ribs or hoops in which pitched ropes or other combustible materials were burned."—Knight's *Pictorial Shakespeare.*

* * * "At my nativity,
The front of heaven was full of fiery shapes,
Of burning cressets."—1 Henry IV. Act. 3, Scene 1.

Cressette is the denominative of *cresset.*

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ordnance planted to the most advantage; and if occasion shall be given, to remove the said artillery as shall seem good to the master of the said ordnance, and in anywise to circumspect that the master-gunners do their duties belonging to them."

Another and more ancient manuscript from the same author, Vol. I. p. 202, gives several curious particulars respecting the power and perquisites of the master of the ordnance, intermixed with the duty of the provost-marshal of the artillery under the following head:—

"These be the authorities and power that the provost-marshall and his lieutenant have in the jurisdiction of the artillery,—

"First, the provost-marshall hath none authority to bear his staff, nor his lieutenant within the jurisdiction of the artillery, without lisence of the provost of the artillery, but let his staff before the artillery gate, as the antient custom is in the realms of France, Spain, Portugal, Naples, and Le Ciceley and Levant.

"*Item.*—If there be any person found in the artillery charged with a crime, so must the provost of the artillery deliver him out of the artillery unto the provost marshall or his lieutenant, reserving always that the said provost of the artillery shall keep for himself all those goods and clothing belonging to the aforesaid 'crymeneux dedely patient.'

"*Item.*—All those of the small artillery, as serpentines, courtoux, bombardes, are bounden, and must foarth with each of their master-gunners, at the commandment of the original master-gunner, upon the pain and correcting of the chief master of the artillery and his councel.

"*Item.*—That all the carpenters are bounden to be by their mantells and works in the artillery, as well in the field as elsewhere, that is in any business to do, upon pain to abide the correcting of the said master and his counsel.

"*Item.*—The master of the artillery shall do cry with sound of trumpet within his jurisdiction of the artillery, with his provost, that all master-gunners of courtoux, or serpentines, and all other being of the same offices, that each man shall keep the ordinances made by the great master of the artillery, every man severally keeping his place, his piece, and their fire and powder; and their servants and boys shall diligently watch upon their masters, and abide by them, to see what they have need of, or anything should lack, as his powder, stores, pellets, necessary unto them where they lie, upon the pain to abide the correction of the master of the artillery, lieutenant, or provost.

"*Item.*—The provost shall go with the lieutenant of the king or prince of the army, with the consent and license of the great master of the artillery, to make place, as is accustomed to be done of old, and that they shall take footmen enough to make a place to shoot, and ditch it as appurtainith, within the which they may bring in their waynes, and carts, with powder and other necessary things, and so thereupon to depute and order in six or seven men deputed or assigned by the master of the artillery, to the defence of the same, upon the pain to be corrected as is aforesaid.

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"And whereas the master of the ordnance is committed and made by any king, prince, or captain-general, and by their counsel, is admitted and charged with the gunners in town or in field, there ought no man without commandment of the said prince, lieutenant, captain-general, and the said counsel, to put no gunner, in or out the said ordnance, without the license of the said master, or the lieutenant for his discharge.

"*Item.*—All other waynes and carts that be laden shall be set in good ordinance as it hath been of old and antient custom to be, on pain as is aforesaid.

"*Item.*—That all the mantells and timber work, basilisques, water mills and other instruments belonging to the sieged town or castle, the which shall be brought so secretly by night and darkness as is possible to be done.

"*Item.*—The gentlemen deputed to give attendance upon the master of the artillery, to govern any bombards or cannon, shall not do nothing otherwise then is ordeyned by the said master of the artillery upon pain to abide the correction of the said master.

"*Item.*—That all servants and officers that have to do under the authority of the master of the artillery, and in his absence his lieutenant and officers, as his chaplain, receivor, comptroller, provosts, and clerks, master-gunners of cortolls[1] or serpentines, and all other servants, as waggoners, carters, their servants, with others shall keep and fulfill all such statutes as are ordeyned by the great master of artillery and his counsel, lieutenant and provost, upon pain to be corrected to the example of all others.

"*Item.*—As a town is won, whether it be by assault, per force, subtile practice, or by any other manner given up, be it town, castle, pile, church, or bastile, or fortress, the chief master of the artillery or his lieutenant, shall ordain, that the master-gunners and their companies shall have the best bell within that place so won, or the church wardens shall appoint or compound with the great master of the artillery and his counsel; and that to be reported by the provost of the artillery, and given knowledge to the lords and rulers of that place so won with the commons of the same, what that the master of the artillery, his counsel, and the master-gunners and their companies have determined and ordeyned, by a couverable and reasonable estimation, to see and know if the lords and commons will hold the ordenance and appointment made.[2]

"*Item.*—That all the butchers of the artillery shall flay their beasts without the precinct of the artillery, and that they grave and bury the filth of those beasts in the earth without the artillery, upon the pain to be, &c. &c.

"*Item.*—That all the horses and other beasts that be killed, or die on their own deaths, being carrion, the provost of the artillery must convey

[1] Courtoux or courtaux.

[2] It is believed that this privilege still belongs to the artillery of all armies. When the town of Fritzlar, in Germany, was captured, the inhabitants were compelled to ransom their bells by the payment of 5000 crowns to the officer commanding the British artillery. This was the only ransom demanded of the inhabitants.

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them out of the park of the artillery, for because of infection, upon the pain of being corrected by the master and counsel, or his lieutenant.

"*Item.*—The provost of the artillery shall have his right of the victuallers within his jurisdiction in likewise as the provost-marshall hath in the great army by estimation."—*Harl. MS.* 4685.

1578. Queen Elizabeth's annual expense for the ordnance as found in *E. Codice, MS.* Taken from a collection of curious papers published by Francis Peck, M.A., dated 1732.

	£	s.	d.		£	s.	d.
Master of the ordnance, fee	151	11	8	Clerk of the small storehouse, fee	36	0	0
2 clerks { the one per diem	0	1	0	Master-gunner of England, fee	66	13	4
2 clerks { the other, do.	0	0	8	2 gunner soldiers, fee a piece per diem	0	1	0
Lieutenant, fee	36	10	0	And each a gunner's room per diem	0	0	8
Clerk	12	13	4	Gunner Smyth, fee „	0	0	8
Surveyor, fee	36	10	0	And a gunner's room at „	0	0	6
Clerk	12	13	4	Gun-stone maker, fee „	0	0	8
Keeper of the great storehouse, fee	50	0	0	And a gunner's room at „	0	0	6
Clerk	12	13	4	Saltpetre-maker, fee „	0	0	6
Keeper of the small storehouse, fee	40	0	0	Carpenter, do „	0	0	8
Clerk of the great storehouse, fee	50	0	0	Engineer or artificer, do. „	0	0	8

109 inferior gunners or cannoneers, viz.—

Fifteen per diem	0	1	0	Eight, per diem	0	0	6
Twelve „	0	0	8	The rest „	0	0	4

Belonging to Fortresses. Berwick.

at	£	s.	d.	at	£	s.	d.
Master of the ordnance, fee	146	0	0	28 gunners of the old ordnance, fee	284	0	0
Muster-master or controller of the check, fee	64	0	0	42 gunners of the great ordnance, fee	580	0	0
Master-gunner, fee	40	0	0	Artificers in the office of the ordnance, fee	2998	19	0

In other castles named (but not copied).

5 master-gunners, each per diem	0	0	8	154 gunners, each per diem	0	0	6

1578. An estimate of the remains in the office of ordnance in 1578 (20 Elizabeth), with the value in ready money of the several titles ensuing, as well within the Tower of London as aboard the ships.[1]

1. Remaining in store within the Tower of London.

Cannons	18
Cannon pieces	1
Demi-cannon	11
Culverings	8
Demi-culverings	20
Sacres	11
Minions	8
Fawcones	7
Fawconets	20
In all	104

2. Remaining on board the ships.

Cannon pieces	24
Demi-cannon	36
Demi-cannon pieces	5
Culverings	76
Demi-culverings	118
Sacres	123
Minions	30
Fawcons	39
Fawconets	3
Fowlers with two chambers a piece, and port pieces	17
In all	504

All which do weigh, by estimation xiii. iiii^{xx}. xv^{mli}. vi^{c}. ii. quarters weight, which being rated at £4 the c weight, with a M. ix^{c}. and lx^{li}. for their carriages; the furniture amounted in money to vii^{m}. vii^{c}. iiii^{xx}. vi.l.[2]

[1] Vide page 362.

[2] *Sic in orig.*

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All which pieces aforesaid do remain as before, over and besides all those that have been uttered out of the store from time to time, for the supply of the forts and castles along the sea coast, and other her majesty's places of strength and service, by sundry warrants from her majesty and the counsel.

3. In the Tower,—

Cross-backed and iron shot, round of several heights	47000
And stone shot for cannon pieces, port pieces, and fowlers	4500
In all	51500

4. Aboard the ships,—

Iron shot	100000
Stone shot	1300
In all	101300

Amounting in money to the sum of £5,475.

5. Powder and stuff for powder in the Tower,—

Corn and serpentine powder	55 lasts.
Saltpetre	10000 weight.[1]
Sulphur	20000 do.
Corn and serpentine powder (dimid)	lasts.

Amounting in money to the sum of £6,617, 10s.

6. Small guns and artillery, munitions, and rich weapons.

(1) In the Tower,

Calivers	7,000
Daggs	5,000
Match	60,000 weight.
Bowes	8,000
Arrows	16,000 sheeves.
Morispikes	10,000
Billes	3,500

(2) Aboard the ships,

Calivers	320
Match	300 weight.
Bowes	380
Arrows	380 sheeves.
Morispikes	460
Billes	460

(3) In the Tower, rich weapons, viz. armed pikes, halberts, partizaunts, javelins, boare spears, pol axes, amounting in money to £2,300. In all £18,877 13*s*. 4*d*. Summa totalis of the value of £38,876 13*s*. 4*d*. The remains £8,876 13*s*. 4*d*.

1583. 28 Feb. A warrant from her majesty to the Earl of Warwick, master of the ordnance, to forward by sea a quantity of shot, powder, and other furniture, to Sir Simon Musgrave, master of the ordnance at Berwick, and the Borders of Scotland.—*Addl. MS.* 5754.

1585. 4 June. A warrant from her majesty to the Earl of Warwick, or the lieutenant of the ordnance, Sir William Pelham, and other officers of the ordnance, to forward supplies of ammunition and stores to Jacques Wingfeld, Esq., master of the ordnance in Ireland.—*Addl. MS.* 5754.

Robert, Earl of Leicester, with forces and fifty gunners, embark for Flanders.

December. A warrant by the Earl of Leicester to —— Wilford, to serve in Ostend as captain of canoneers; he afterwards became celebrated for his defence of Leith in Scotland.—*Harl. MS.* 5753.

[1] *Sic in orig.*

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Letter from Sir Francis Walsingham to the Earl of Leicester.—"That the report of 100 pieces of brass ordnance, being missing through Sir William Pelham's neglect in overlooking his inferior officers, had like to have hindered his coming over into Holland to assist him with his advise, the Queen was so much offended with him."—*Harl. MS.* 285, 61.

1588. July. The proportion of ordnance for the army appointed to be drawn together to encounter the enemy,—

	Ordnance.	Horses.		Ordnance.	Horses.
Demi-cannon	4	18	Sacres	3	7
Culverins	4	14	Falcons	2	3
Demi-culverins	3	12	Minions	2	6

To each of the same pieces so many horses.

The proportion of ordnance that is appointed for the guard of her majesty's person.

	Ordnance.	Horses.		Ordnance.	Horses.
Cannon	6	24	Demi-culverins	6	12
Demi-cannon	6	14	Sacres	6	7
Culverins	6	14	Minions	6	6

To each of the same pieces so many horses.

Harl. MS. 168, pp. 173, 174.

28 Oct. A warrant from her majesty to the Earl of Warwick, master of the ordnance, to forward supplies of ammunition and stores to Sir George Carew, master of the ordnance in Ireland.—*Addl. MS.* 5754.

Rates of entertainments of the officers of the companies for the service of the year 1588.

	per diem.	£	s.	d.
Master of the ordnance		0	10	0
Lieutenant		0	6	8
Inferior officers of the ordnance:—				
10 laborers				
Muster-master		0	6	8
4 clerks at 2*s.* each		0	8	0
Commissary of victuals		0	6	8
1 clerk		0	2	0
Proof-master		0	6	8
Master of the carriages		0	4	0
Master-carter				
Four clerks				
Quarter-master		0	10	0
6 farriers				
Provost-master		0	6	8
2 tythers,[1] at 1*s.* 4*d.* each		0	2	8
Judge-general		0	2	8
Entertainment of the officers of the regiment:—				
Colonel, being a nobleman		1	0	0
He being a private, or nobleman's son		0	13	4
Lieutenant-Colonel		0	6	8

Harl. MS. 168, p. 175.

1589. Ambrose Dudley, Earl of Warwick, master of the ordnance died the 21st February.

"Earl of Warwick, after his preferment to the office of the master of the ordnance, was besieged in the town of Newhaven in Normandy by Charles IX. of France. As he stood on the rampier at a parley, he was shot, contrary to the laws of arms with a bullet impoisoned, which consumed his leg; and thereof after he had lived several years with great pain and impotensy, endured his leg to be sawed from his body, and died a few days after."—Thomas Louch's *Life of Sir P. Sidney*, p. 206.

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[1] "*Tith.* Tight or strong."—*Dictionary of Archaic and Provincial words.*
Tythers. Strong men attached to the provost-master, to assist him in his duties.

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A letter from Sir P. Sidney to the Lord Treasurer stating, "The queen at my Lord Warwick's request, hath been moved to join me in his office of ordnance, and as I learn her majesty yields gratious hearing to it." Dated 27th January 1582.—*Harl. MS.* 6993, p. 471.

The appointment of master of the ordnance held by commission until 1596.

1590. 5 June. Her majesty's warrant to Sir Robert Constable, knight, lieutenant-general of the ordnance, to forward ammunition and stores to Sir George Carew, master of the ordnance in Ireland.—*Addl. MS.* 5754.

1594. Sir George Carew appointed lieutenant of the ordnance at £72 per annum; William Pastheriske, surveyor at £56 per annum. The appointments as follow were held by;—clerk of the ordnance Stephen Ridlesden at £71; storekeeper Thomas Bedewell at £40; clerk of the deliveries George Hogge at £18 5*s.*; clerk to the master-general, William Cudner £18 5*s.*; master-gunner of England, Stephen Bull at £70; keeper of the small guns Richard Paulfreyman at £50 per annum.

The master-gunner of England taught his schollars to shoot in great ordnance at the artillery garden.—Taken from the *Ordnance Quarter Book* for October.

1595. William Lamon, proof-master, at £3. To Henry Pitt, Richard Phillips, Samuel Gaine, and Peter Gill for casting brass ordnance out of her majesty's metal. To Robert Goare, gun-stone maker, for several sorts of stone shot brought into her majesty's stores.—From the *Quarter Book.*

1596. Robert, Earl of Essex, appointed master of the ordnance.

Sir George Carew, lieutenant of the ordnance with artillery embarked with the expedition to Cadiz, under the Earl of Essex, where they captured 1200 pieces of ordnance taken or sunk.

12 Feb. Stores and ammunition delivered from the Tower of London for Sir George Bourcher, master of the ordnance in Ireland.—*Addl. MS.* 5754.

1597. Sir George Carew, lieutenant of the ordnance, and Sir Christopher Blount as first colonel with artillery embarked with the forces under the Earl of Essex on an expedition to the Islands of the Azores.

John Lee appointed storekeeper to the ordnance.

John Linewray appointed jointly clerk of the deliveries with George Hogge.

Establishment of Artillery

In the reign of Queen Elizabeth, especially in the year 1597 is as follows, viz.—

	£	s.	d.
Sir George Carew, knight lieutenant of Her Majesty's ordnance, for his allowance one quarter	18	0	0
William Parkeringe, surveyor of Her Majesty's ordnance, for his like quarter's allowance	18	0	0
Stephen Riddleshen, clerk of Her Majesty's ordnance, for his like quarter's allowance	17	12	0
John Lee, keeper of H.M. stores, do.	10	0	0
George Hogge, and John Lynewrace, clerks of deliveries	13	11	4
William Oudner, clerk to Sir George Carew, Knight	4	11	2

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Clerks daily attending in the said office for three months, at £5 each.

Richard Palfreyman.	Thomas Lemmas.
Edward Pasheringe.	John Squire.
William Scott.	Richard Lentall.
Richard Huynes.	That is, for one quarter's salary..... £116 14 6

1598. John Davis appointed surveyor-general. He was knighted the following year.

1599. Names of the ordnance used in the navy. Taken from a return of the ordnance, dated 6th April 1599.

	Bore, inches.		Bore, inches.
Cannon	8	Falconets	2
Demi-cannon	6¾	Port piece hall	
Culverins.....	5½	Port piece chambers	
Demi-culverins	4	Fowlers hull	
Sakers... } Mynions }	3½	Fowlers chambers.....	
Falcons	2½	Curtalls	

With the army in Ireland under Lord Mountjoy, there were 1600 gunners, cannoniers, armourers, and clerks of the ordnance.—Grose's *Military Antiquities.*

The Earl of Essex suspended from his office of master of the ordnance.

1601. John Linewray appointed surveyor-general. Robert Johnson appointed clerk of the deliveries.

1603. James I. Charles Blount, Earl of Devon, appointed master of the ordnance.

John Pavye appointed clerk to the master of the ordnance.

1604. Sir Amias Preston, knight, appointed storekeeper to the ordnance.

The principal officers of the ordnance knighted in this year,—

1605. Sir George Carew, lieutenant-general of the ordnance, created Baron Carew.

1606. Sir Roger Dallison appointed master-surveyor of the ordnance.

1607. William Bull appointed master-gunner of England. Francis Morris appointed clerk of the ordnance.

1608. Lord Carew appointed master-general of the ordnance; Sir Roger Dallison, knight, appointed lieutenant-general to ditto; Sir John Key, knight, appointed surveyor-general to ditto; Richard Paulfreyman, appointed clerk to the master-general.—*October Quarter Book.*

1609. Sir Roger Arconghilt appointed storekeeper to the ordnance. George Hooker appointed clerk to the master-general.

1611. William Hamond appointed master-gunner of England.

1612. Samuel Hales appointed storekeeper to the ordnance.

James Paulfreyman appointed keeper of the small guns and shot.

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1616. Sir Richard Morrison appointed lieutenant of the ordnance. Nedtracy Smart appointed storekeeper to ditto.

The names of all the officers called masters of the ordnance in England, which was an office first created by Henry VIII.

Sir Thomas Seymour.
Sir Phillip Hobbye.
Sir Richard Southwell.
Ambrose Dudley, Earl of Warwick.
Robert Devereux, Earl of Essex.
Charles Blount, Earl of Devon.
Sir George Carew, Baron Carew of Clopton.

The names of all the officers called lieutenants of the ordnance in England, which was an office first created by Henry VIII.

Sir Christopher Morrys.
„ Francis Flemyng.
„ William Bromfield.
„ Edward Randolphe—in Ireland.
Sir William Pelham.
„ Robert Constable.
„ George Carew, Baron Carew of Clopton.

Harl. MS. 5180, p. 83.

1618. Establishment of the train of artillery.

1 General of artillery.
1 Lieutenant of do.
10 Gentlemen of do.
25 Conductors of do.
1 Master-gunner
136 Gunners.
1 Petardier.
1 Captain of miners.
25 Miners.
1 Captain of pioneers.
25 Pioneers.
1 Surgeon.
1 Surgeon's mate.

SMITH'S *Military Dictionary.*

1620. Thomas Powell appointed storekeeper of the ordnance; Edward Johnson, ditto, clerk of deliveries; John Brown, master-founder of the iron ordnance, and Richard Phillips one of his majesty's founders for brass ordnance.

4 July. At Whitehall the 4th July, 1620.

Present.

Lord Privy Seal ..... Mr Secretary Maunton.
Earl of Arundell ..... Mr Secretary Calvert.
Earl of Southampton ..... Mr Chancellor of the Exchequer.
Lord Digby ..... Master of the rolls.
Mr Treasurer ..... Sir Edward Cooke.

"Whereas the Tower of London being his majesty's royal castle, one of the principal and most eminent forts of this kingdom, a great strength and ornament to the city, the chief storehouse and magazine of warlike provisions of this kingdom, hath antiently been fortified, not only within the walls, ditches, and wharfs of the same, but also such care taken in the minorits,[1] and other neighbouring places, as well for the lodging and receipt of the principal officers of the ordnance, as likewise for artificers, gunmakers, wheelers and others, whose trades are appropriated to military ends, as nothing was there almost wanting, which was fit for the state to provide either for honour or safety.

"But for as much in these latter times, either through the evil example or tolleration of some lieutenants of the tower, or by abusing of trust reposed in some officers who have particular relation to the place; there hath insencibly crept in diverse abuse and incroachments whereby the said

[1] The Minories.

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antient limits of the tower, and those other habitations and storehouses appointed for public use are now perverted to private profit; the splender and magnificence of the said Royal Castle being by that means defaced, and the place itself as it were besieged in the wharf, ditches, and liberties thereof."

Upon complaint made of all which abuse the Board ordered as follows:—

"That whereas there was a lease procured from his majesty to William Hammond, master-gunner of England in the Tower of the artillery yard near unto the minorits, and an antient obsolete name of the tifal yard for 223 years, and the same lease being defective and apparently void, and so acknowledged by the said Hammond and his councel, for manifest imperfections found out by the said Sir Edward Cooke, was by the said Hammond delivered into the hands of the said Sir Edward Cooke, and now remaining in the councels chest.

"It is ordered that the said artillery yard be for the future restored to the public use for which it had been formerly employed, viz. for exercise of arms and artillery, and that the same shall not henceforth be alienated or converted to any other use:

"And whereas likewise there are leases procured from his majesty as well by as for Sir Richard Dallyson, Knight and Bart., late lieutenant of the ordnance, for 60 years of divers houses in the minorits, belonging to the office of ordnance, and therefore reserved for gunmakers, wheelers, and other artificers serving for the defence and safety of the realm. As also by Sir Thomas Mounson, late master of the armory, and likewise divers leases procured by divers persons, some of part of the tower wharf, others part of the tower ditch, the portcullis, and posterne gates, divers whereof as the said Sir Edward Cooke affirmed were void in law:

"It is ordered that as well the said houses belonging to the said office of ordnance and armory, as also the tower wharf, tower ditch, portcullis and posterne gates, be restored to their former use respectively and not alienated or converted to any other private use, upon any occasion for the future. And for as much as Sir Roger Dallyson and Sir Thomas Mounson, did when they were officers to the king, contrary to the trust in them reposed, procure their said estates to his majesty's prejudice and dis-service: it is ordered that they be both called to the Board, where the king's councel learned in the law are likewise to attend, and there they shall receive their lordships further pleasure, &c. &c."

1620. 4 July. Report made to the Prince's Higness in councel by Sir Richard Morryson, lieutenant of the ordnance, of the forts, castles, &c. on the sea coast, and a survey and remains of ordnance, shot, stores, &c. in the Tower of London with the names of the officers of the ordnance.

	Salary	£	s.	d.
The Lord Carew, master of his majesty's ordnance				
Sir Richard Morryson, knight, lieutenant of do.		76	13	4
Sir John Kay, knight, surveyor of do.		36	10	0
Francis Morris, Esq., clerk of do.		36	10	0
Thomas Powell, Esq., clerk of the stores		54	13	0
Edward Johnson, Esq., clerk of the deliveries		18	5	0

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Other inferior officers and artificers.

	£	s.	d.
Gun foundery, 6	114	10	10
A founder of shot	9	2	6
A stone shot-maker	12	3	4
John Luggar, case maker	9	2	6
Henry Rowland, gun maker	24	6	8
Another gun maker	12	3	4
A cross-bow maker	6	1	8
John Jefferson, bowyer	9	2	6
John Powell Fletcher	9	2	6
A bow-string maker	9	2	6
Matthew Banks, carpenter	12	3	4
William Smeadon, wheelwright	15	5	0
A purveyor of arms	12	3	4
Anthony Feraby, purveyor for timber	12	3	4
Lewis Tayte, the master-smith	9	2	6
John Fletcher, rope and match maker	12	3	4
Hugh Peice, porter of the minorits	12	3	4
John Reynolds, master-gunner of England.			
7 gunners, double fees.			
13 do. each at	0	1	4
69 do. „	0	0	8

Brass ordnance mounted, serviceable.

Cannon of 7 and 8 inches	20	Port piece hall[1]	10
Cannon perriers	7	Chambers for them	44
Demi-cannon	16	Fowlers halls[1]	56
Culverins	36	Chambers for them	76
Demi-culverins	18	Basse	2
Sakers	16	Rabbonets	18
Minions	13	Mortar pieces	7
Faucons	9	Bombard	1
Fauconetts	15	Pieces for shooting divers bullets	2

Cast-iron ordnance, dismounted.

Culverins	10	Minion	1
Demi-culverins	44	Faucon	1
Sakers	36		

With small guns, rich weapons, weapons for service, weapons for devastation, corn powder, match, round shot iron, cross-barred shot, chain shot, and Langrell cases with broad square, and Hayle shot, &c.[2]

"The state of the receipts and deliveries from the death of King Henry VIII., the 27th January, 1546, to the last day of December, 1561, Edward VI. and Queen Mary, wherein is remembered the whole mass and stores at this day remaining in your several armouries, and in the hands of your nobility and subjects:

"From Winchester-place in Southwark, then the house of the Marquis of Northampton,

Demi-lances ..... 160 | Corslets 2

From Puckeridge, in the county of Hertford, the armoury of Doctor Cranmore, late Abp. Almaine R——, steel saddles 180.

Hanse Hunter, the Queen's armourer, maces 457—Elizabeth.

Sir Richard Southwell, master of the armoury to Queen Mary, shaffrons 329.

Sir George Howard, master of the ordnance to Queen Elizabeth.

Mr William Winter, master of the ordnance to Queen Elizabeth.

The Lord Darcie, master of the ordnance in Edward VI.

James Fuller, yeoman of the armoury, Greenwich—Elizabeth.

Sir Thomas Gresham, factor for King Edward VI. beyond the seas.

Corslets leather, barbes aynetts. One Sir Henry Palmer, kt., master of the ordnance at Bolloign, 4th Edward VI.

Remains in the Tower armoury. Westminster armoury.

Hampton Court armoury."

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[1] *Sic in orig.*

[2] Much of what follows is so badly copied in the MS. as to be nearly unintelligible.

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"Marrions collars vambrace, 22 pair gantlets, 32 pair leather barbes, sallets, and skulls, shirts of mail, sleeves of mail, burgonets, collars anymes, targets, swords, paring staves, punching staves, counter burrs, harness for King Henry VIII. A brigandine for his own person, cannon perrier, bombard port pieces, morrice pikes, javelins, &c."

Clerks of the ordnance, anno 28, Henry VIII., as appear by old records in the office:—

Mr George Hagge.
Mr John Linewraye.
Mr William Hurley—the money.
Mr Anthony Anthony—the store.
Mr Rogers succeeded Mr Hurley.

In Queen Mary's time,—

Mr Painter possessed of a gunner's fee, became clerk of the ordnance by the friendship of Sir Richard Southwell, knight, master of the ordnance.

In Edward VI., when Sir Francis Fleming was lieutenant of the ordnance, the said Anthony was surveyor of the ordnance, and Brian Hogge clerk of the ordnance.

List of master-gunners of England:—

Christopher Gould.		William Hammond	Elizabeth.
Richard Webb	Elizabeth.	John Reynold.....	"
Anthony Fourntler, a soldier ...	"	John Wornn, Esq., an experienced soldier, a Scotchman by birth.	
Stephen Bull	"		
William Bull		Fee per annum £36. 10s.	

Master-gunners out of the ordinary of the office,—

By title of proof-master for proving of ordnance powder, saltpetre, and match. 200 scholars sworn to the practice of shooting in great ordnance. For powder, shot, match, planks, and wadding. Spent in training of scholars at the artillery garden.

The yearly allowance due by presidents unto the office of ordnance, 1599.

	£	s.	d.		£	s.	d.
To the master of the ordnance				To the clerk of the office	69	0	0
To the lieutenant	72	0	0	To the clerk of the deliveries ...	18	5	0
To the surveyor	56	0	0	To the keeper of the stores	26	8	0

The copy of Mr Linewraye's book of reformation of abuses in the office of ordnance.

1st. False receipts charged upon the keepers of the stores,—

One painter was convicted in the exchequer for the sume of £500. The great gally, Sir John Luttrel, captain of the same. This indenture made at the Tower of London the 31st June, in the 36th year of the reign of Henry VIII. between Sir Thomas Seymour, knight, master of the king's ordnance, and Thomas Serjeant, master-gunner of the said ship, Sir Christopher Morrice, kt. Henry VIII., per annum £66. 8s.; he lies interred in St Peter's Church in Cornhill, by the title of master-gunner of England to Henry VIII.[1]

Sir Francis Fleming, kt., 1553, tempore Henry VIII. Edw. VI. March. Sir Robert Southwell entered the 26th February, 1st Queen Mary. Sir —— Bromfield at Newhaven, 4th Elizabeth 1563.

Edward Randolph, Esq., in Ireland 1556, the 8th Elizabeth, lieutenant of the ordnance.

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[1] *Vide* STOWE's *Surry*, folio 196 and page 211, Morrice. Yet in the chronicle I find that in 1544 his title was master of the ordnance.

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Sir William Pelham died in Ireland 1587, or in Flanders the 19th January; he lies interred in the minorits church.

Sir George Carew, kt., from 1592 to Midsummer 1608.

Sir George Dallysore, from 3rd January, 1607, finish 1608 and 1615.

Sir Richard Morryson, sen., from Midsummer 1615, the 4th Jacobi. Sir William Harrington.

Sir William Heydon, kt., Midsummer 1626, drowned in the voyage with the Duke of Buckingham to the Isle of Rhee.

Captain John Heydon after him, 1627.

November 23, 1567. For removing of powder out of the vault in the White Tower.

Mr Richard Webb, master-gunner for 24 days £1. 4*s*. In 1568 I find, for casting leaden bullets for carriers and culverins; when drawing and removing of powder out of one place to another, when mounting of ordnance; so that it appeareth in those days, labourers were not trusted about the powder, &c.—*Harl. MS.* 5912.

1620. A King's Warrant and a list of the Royal Army intended to be raised for the recovery and protection of the Palatinate, consisting of 25,000 foot, 5000 horse, 20 pieces of ordnance and artillery, with their officers, artificers, and attendants, ammunition, stores, pay, &c.

Nature of ordnance.

		No.
With block carriages.	Mortars, brass	2
	Cannon royal	4
	Demi-cannon	4
	Culverins	6
	Demi-culverins	4
	Sakers	2

	Per diem. £	*s.*	*d.*
The master of the ordnance	3	0	0
The lieutenant	1	0	0
A surveyor	0	6	8
2 clerks, each	0	2	0
1 auditor	0	6	8
2 clerks, each	0	2	0
Aray master	0	6	8
2 clerks, each	0	2	0
A convoy master-general	0	10	0
6 engineers for fortifications, each	0	6	8
1 clerk and 3 conductors of the works, each	0	2	6
The clerk of the ordnance	0	6	8
4 clerks, each	0	2	6
9 gentlemen of the ordnance, each	0	3	0
30 harquebussers, each	0	1	6
A quarter-master	0	5	0
8 labourers, each	0	0	10
4 horsemen, to attend the quarter-master, each	0	1	6
3 farriers or labourers under him, each	0	2	0
A commissary of victuals	0	5	0
2 clerks under him, each	0	2	0
A commissary for the horses, carts, and powder	0	6	8
2 clerks to attend him, each	0	2	0
A purveyor-general, both for the numerous victuals, and all other necessaries belonging to the ordnance	0	6	0

	Per diem. £	*s.*	*d.*
Yeoman allowed him	0	1	6
A master of the carriages for the artillery	0	6	0
2 halberdiers to attend him, each	0	1	0
The master of the miners	0	5	0
25 other miners, each	0	2	0
3 conductors of the carriages, each	0	3	0
3 captains (to 450 pioneers), each	0	4	0
3 lieutenants, each	0	2	0
3 conductors of the pioneer works, each	0	1	6
2 chief petardiers, each	0	6	8
To every of the 10 attendants, each	0	1	6
1 master-gunner	0	6	0
3 master-gunner's mates, each	0	2	6
3 constables or quarter-gunners, each	0	2	0
124 other gunners, each	0	1	6
212 labourers, each	0	1	0
1 provost-master of the artillery	0	5	0
3 provosts, each	0	1	6
3 under do., each	0	1	0
1 founder of brass ordnance	0	3	0
Man at	0	2	0
Master of the fireworks	0	4	0
1 drummer	0	1	0
1 trumpeter	0	2	0
1 barber-surgeon	0	2	6
2 under barber-surgeons, each	0	1	0
1 master-carpenter	0	3	0
2 mates, each	0	2	0
24 other carpenters, each	0	1	6
1 master-smith	0	3	0
2 mates, each	0	2	0
18 servants, workers for 3 forges, each	0	1	6
1 master-cooper	0	3	0
2 mates, each	0	2	0
18 servants, each	0	1	6

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	Per diem. £	s.	d.
1 farrier	0	2	6
6 servants, workmen, each	0	1	6
450 pioneers, each	0	0	8
65 conductors, each	0	2	0
3 tent-makers, each	0	2	0
9 servants to them, each	0	1	0

	Per diem. £	s.	d.
1 armourer	0	3	6
4 servants to him, each	0	1	6
1 collar-maker	0	3	0
4 servants to him, each	0	1	6
200 horses, each	0	1	0
100 carters, each	0	1	0

Harl. MS. 5109.

1623. John Reynolds appointed master-gunner of England.

30 July. A survey made of the castles, forts, and places, found placed on either side of the river Thames and Medway; and also of the castles, forts, with all their fortifications along the coasts of Kent, Sussex, Hampshire, and so onwards to the south coast, west, and to the Land's End, including the forts of Cornwall, by Sir Richard Marryson, kt. lieutenant of his majesty's ordnance, Sir John Ogle, kt. and colonel, Sir John Kay, surveyor of his majesty's said ordnance, in pursuance of certain instructions from the lords higness most honourable privy council.—*Harl. MS.* 1326.

Charles I. In Charles I. reign, Vicount Valentia, the master-general of the ordnance, was joined in a commission as councel to the Duke of Buckingham, when he commanded in chief the fleet.

1625. Sir William Harrington appointed lieutenant-general of the ordnance.

Sir Alexander Brett, appointed surveyor-general.

Lord Carew, master-general, created Earl of Totness.

1626. Sir William Heydon, kt., appointed lieutenant-general of the ordnance.

King Charles granted a patent for fourteen years to Arnold Rotispen, for making guns of all sorts, both great and small, after a new way or manner, not formerly practised by any within these dominions.—RYMER.

Sir William Heydon, lieutenant-general of the ordnance was drowned on the landing of the expedition under the Duke of Buckingham at the Isle of Rhee.

1627. Sir John Heydon appointed lieutenant-general of the ordnance.

1 Oct. Sir Paul Harris, bart., appointed surveyor-general.

1628. Paid to Sir Sackville Trevor, kt., for the price or value of one culvering of brass, which was taken in the French prize, called "St Esprit," and allowed unto him by an order from the lords of his majesty's privy council, the sum of £208. 6*s.* 8*d.*

1629. The British artillery were employed and extremely active at the famous siege of Bois le Duc, which commenced in May under the Prince of Orange, and surrendered the 14th September.

1630. Lord Vere of Tilbury appointed master-general.

18 Nov. Commissioners and assistants to them for the office of ordnance.—This day came into this office, the Lord Vic Wimbleton, Vic Dorchester, and Mr Secretary Cook, 3 of the commissioners for this office, and Sir Henry Spiller, Sir Kellan Digby, and Mr Bingley, assistants to the said commissioners and presented their commissions.—*Harl. MS.* 429.

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1631. Francis Coningesby appointed surveyor-general.

1632. The British artillery employed at the siege of Marstrickt with the army under the Prince of Orange, which capitulated the 24th Aug.

1633. George Clerk appointed clerk of the deliveries.

1635. Mountjoy, Earl of Newport, appointed master-general; Richard March appointed store-keeper; Thomas Barnard appointed clerk to the master-general.

20 Mar. Commissioners for the ordnance and gunpowder,—

Earl Marshall, the Earl of Arundell.	Lord Cottington.
Earl of Dorset.	Sir John Coke, Kt.
Earl of Newport.	Sir Francis Windebank, Kt.
Lord Vic Wimbledon.	

A warrant to grant from time to time such powder as the master of the ordnance may require, dated 20th March in the 10th year of our reign, 1635.

1636. Edward Sherburne appointed clerk of the ordnance.

1638. King Charles directed a cannon to be cast in this year, which was placed in St James's park, it was emphatically called "The Gun," bearing this inscription,—

Carolus Edgœri sceptrum stabilivit aquarum.
"The sceptre of Edgar established on the waters by Charles."

N.B.—The gun has since been removed to the Repository at Woolwich, where it now (1845) remains.

Extract from March *Quarter Book*.—The Earl of Newport, master-general; Sir John Heyden, lieutenant-general; John Reignolds, master-gunner of England.

June *Quarter Book*.—James Weymes, master-gunner of England.

1639. A list of the train of artillery, according to his majesty King Charles I. directions, reduced to such a number of officers and other ministers as will be merely necessary for a train of 30 or 40 pieces of ordnance for the army against the Scotch :—

	per diem.	£	s.	d.
The general of the ordnance		4	0	0
Lieutenant		1	0	0
A comptroller		0	10	0
2 commissaries of the two magazines of ammunition	the train		6	0
	the army		5	0
4 clerks under them, each		0	2	0
1 engineer		0	8	0
ditto		0	6	0
2 clerks for them, each		0	2	0
6 conductors of the trenches and fortifications, each		0	2	0
1 fire worker		0	3	0
His assistant		0	1	8
1 petardier		0	2	6
12 assistants, each		0	1	0
1 master-gunner		0	6	8
4 gentlemen, each		0	4	0
Gunners mates, each		0	2	6
30 gunners, each		0	1	6
A paymaster		0	5	0
Captain of the pioneers		0	5	0
Quarter-master		0	4	0

	per diem.	£	s.	d.
4 conductors of the mattrosses, each		0	2	6
40 mattrosses, each		0	1	0
A purveyor		0	3	0
1 master-smith		0	3	0
6 servants under him, each		0	1	0
1 master wheelwright		0	2	6
4 servants under him, each		0	1	0
1 tent maker		0	2	8
2 servants, each		0	1	0
1 tent keeper		0	1	6
1 assistant to him		0	0	8
1 master-carpenter		0	3	0
6 servants under him, each		0	1	0
1 cordage maker		0	2	0
2 servants under him, each		0	1	0
4 armourers, each		0	2	6
4 servants under them, each		0	1	0
2 gun-smiths, each		0	2	6
4 servants, each		0	1	0
1 harness maker		0	1	6
2 servants under him, each		0	1	0
1 farrier		0	2	6

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	per diem.	£	s.	d.
2 servants under him, each		0	1	0
1 bridge-master		0	2	6
6 servants, each		0	1	0
1 provost-marshal		0	2	0
2 servants under him, each		0	1	0
1 surgeon		0	4	0
1 servant under him		0	1	0
1 wagoner for the train		0	5	0
1 assistant to him		0	2	6
1 saddle-maker		0	1	6

	per diem.	£	s.	d.
1 servant under him		0	1	0
1 cooper		0	2	0
2 servants under him, each		0	1	0
2 principal conductors, ammunition of the army, ditto of the artillery, each		0	3	0
40 conductors, twenty for the wagons, twenty for the ordnance, each		0	2	6
Commissary for the draught horses		0	4	0
2 assistants to him, each		0	2	6

GROSE'S *Military Antiquities.*

1640. Thomas Eastwood appointed clerk of the deliveries.

Sept. A list of such officers and ministers belonging to a train of artillery as are necessary, and now resident in London, viz.—

As comptrollers of artillery at 8*d.* per diem,—

Captain Younger, whose payment according to agreement with Sir Nicholas Biron, who took him from his employment in the Netherlands, was stated upon the lists of the Lord Marquis his troops at 15*s.* per diem, and remaineth amongst those that are still continued in pay, which he acknowledges to have received from Captain Vernon by the Lord Marquis his appointment until the 18th August last. But his lordship being in the north (whither he was directed and intended to have repaired) the lord marshal was pleased to stay his journey, and to command his attendance here upon the intended train of artillery. In which respect he humbly prayeth some speedy award may be taken for the assignment of his payment here.

Gentlemen of the ordnance allowed 4*s.* per diem as appear by his majesty's list,—

Henry Bludder, Edward Danker } For gentlemen of the ordnance.

Both formerly of the Lord Marquis' train, each at 2*s.* per diem.

Battery-masters, one at 5*s.*, the other 4*s.* per diem,—

Nicholas Samson, fit for a battery-master, formerly a serjeant under the Lord Marquis at 1*s.* 6*d.* per diem.

Conductors of the trenches, each 2*s.* per diem,—

Richard Huckley for a conductor of the trenches as serjeant at 1*s.* 6*d.*

Conductors to the train, each at 2*s.* 6*d.* per diem,—

William Griffith, Clement Lynne } For conductors to the train of artillery as formerly to the Lord Marquis at 1*s.* 6*d.* each.

Harl. MS. 6851.

1642. His majesty directed Captain Green, comptroller of the artillery to join him.

22 May. His majesty's warrant appointing Lord Percy general of the train of artillery with the army.—*Harl. MS.* 6804.

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20 Aug. Extract from the Journals of the House of Lords,—
Lord Wharton, speaker.

The House was informed, that Mr March, one of the officers of the ordnance, was required, from the Earl of Essex, lord-general, to deliver the keys of the office of ordnance, that ammunition might be had there, for the present service of the king, kingdom, and parliament; who thereupon petitioned the said lord-general as followeth, viz:—

To the right honourable Robert, Earl of Essex, his excellency.
The humble petition of Richard March, keeper of his majesty's stores.

Shewing,

"That your lordship's petitioner, having this present day received a warrant from your excellency, for delivering up the keys of the stores of arms remaining in his custody, doth, in all humbleness, profess his willingness to obey your lordship's commands, but, for your lordship's better satisfaction herein, humbly prays that your lordship would be pleased to take into your honorable consideration the petition annexed, prepared by the petitioner and other the officers of the ordnance, for their enlargement, wherein the petitioner and they become humble suitors for your lordship's honorable favour.

"And the petitioner shall pray,
for your lordship,
"RICHARD MARCH."

A petition of other officers of ordnance, to the lords of parliament to the same effect.

To the Right Honourable the Lords and Peers now assembled in Parliament.

The humble petition of Captain Francis Conningsby, Richard March, and Edward Sherburne, officers of his majesty's ordnance,

Shewing,

"That whereas your lordships petitioners have been divers days under restraint by your lordships commands, for not giving consent to the issuing of some munition in their custody; the petitioners humbly pray, that your lordships will be pleased to take into consideration.

(1) "That they are strictly bound, by the duty of their place, not to dispose of the munition in their custody contrary to his majesty's pleasure.

(2) "That before the petitioners received any commands from the right honourable the Earl of Essex his excellency, for the delivery of the munition in the warrant expressed, the petitioners received strict command, under his majesty's sign manual, not to issue out any munition without express warrant from his majesty.

(3) "That the petitioners have, these four years and a half, been unpaid the fees, and allowances belonging to their places.

"Therefore their humble suit is, that in regard the giving of their consent to your lordships commands in this particular, would not only be a great breach of trust in them, but tend to their undoing; that your lordships would

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be honorably pleased to accept of their willingness and cheerfulness to obey your lordships commands, so far as may stand with their own integrity and safety, and that your lordships would be pleased to release them from their present restraint whereby they are put to great charge, and suffer much in their own private occasions.

"And your petitioners shall ever pray,
for your lordships,

"FRANCIS CONNINGSBY,
RICHARD MARCH,
EDWARD SHERBURNE."

It is ordered, by the lords and commons in parliament assembled, that the officers of the ordnance in the Tower of London shall forthwith, upon sight of this order, deliver the keys of the office of the ordnance, arms, ammunition, and stores there, to such as the committee for the defence of the kingdom shall appoint to receive them; or else that the doors of the said office shall be forthwith broken up, and the charge and keeping of the said arms shall be committed into the hands of such as the said committee shall think fit; who shall take inventories of the same, to the intent that a true account may be taken of the said arms to the use of his majesty, the parliament, and the kingdom.

22 Oct. His majesty's warrant for a proportion of ordnance to accompany 4000 foot.

Brass ordnance { Demi cannon.....2
Culverings.....2

with their ammunition, materials, and attendants.

Captain Younger .....Comptroller	The master-carpenter
Monsieur Shebith .....Engineer	6 carpenters
Bodewinde De Hayne.	3 or 4 wheelwrights
Mr George Cole ..... { Clerks of the munition	3 coopers
Mr Matthew Wharton { of the ordnance and foot.	A ladle-maker
	A smith and his servants
Henry She ..... } Gentlemen of the ord-	Henry Elsey, and all the matrosses
William Sneddall ..... } nance	All the pioneers
Wm. Betts to be the chief gunner, and 8 gunners	6 conductors
more, whereof Richard Bury to be one	A fireworker

All the aforesaid officers, artificers, &c. are to be selected, and made choice of by Captain Younger, Comptroller.

Mem. This proportion assigned for Banbury but countermanded, in regard the whole train the next morning marched to Edghill.

22 Nov. At a counsell of war held at Reading, his majesty resolved that Sir John Heydon, kt., lieutenant-general of the ordnance, should send away to Oxford 8 pieces of ordnance, consisting of

Brass ordnance mounted,—

Culverings.....2	6-lb. bullet.....1
Demi-culverings 2	3-lb. bullet.....1
12-lb. bullet 2	

with their ammunition material, and attendants,—

Gentlemen of the ordnance:—	2 Conductors
Mr Stone	1 Clerke
Mr Sherborne	8 Mattrosses
8 Gunners	8 Pioneers.

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1643. Table, extracted from a work dedicated to the Duke of Buckingham by Robert Norton, engineer and gunner.

Names of the Pieces.	Height of Bore.	Length in Diameters.	Weight in Metal.	Weight of Powder.	Length of the Ladles.
	inches.		lbs.	lbs.	inches.
Cannon of 8	8	15	8000	40	24
Cannon of 7	7	16	7000	25	22
Demi-cannon	6½	18	6000	20	21
Culvering	5½	28	4500	15	20
Demi-culvering	4½	32	2500	9	18
Saker	3½	36	1500	5¼	16
Minion	3¼	30	1200	3¼	15
Falcon	2¾	42	700	2½	14
Falconet	2¼	48	500	1¼	12
Cannon-perior	9, 10, 12	8	3500	3, 3½, 4	3
Demi-can, drake	6½	16	3000	9	4½
Culvering drake	5½	16	2000	5	4½
Demi-culvering drake	4½	16	1500	3½	4½
Saker drake	3½	18	1200	2	4½

Earl of Marlborough general of artillery; John White appointed clerk of the ordnance, John Falkener storekeeper to do; Stephen Darnelly Clerk of deliveries to do.—*Ordnance Quarter Book for January.*

Sir Timothy Tyrrell styled governor and general of the ordnance.

John Pym, Esq. appointed lieutenant of the ordnance, he died the 8th December of the same year.

Sir David Walter appointed lieutenant-general of the ordnance.

George Taylor, surveyor-general to ditto.

30 Oct. Henry Lord Percy, Baron of Alnwick, master of the horse to his highness the Prince of Wales, and general of his majesty's train of artillery:

To Claud' Pelett de la Rinere, gentleman of the ordnance.

"By the power and authority given me from our sovereign lord King Charles under the great seal of England, as general of his majesty's train of artillery, I do hereby constitute and appoint you gentleman of the ordnance for his majesty's service; in which place you are to do and conform all things insident, and belonging to your said charge commanding those whom it may concern to obey you as gentleman of the ordnance, according to this commission given you, and you are to observe and follow such orders, and directions as you shall receive from myself, and your superior officers belonging to the train of artillery according to discipline of war."

From Sir William Vavasor to the Lord Percy, general of the ordnance.

My Lord,

"We have taken Panswick with the loss of some men, and waist of much ammunition. The rebels have possessed themselves of many houses which will be taken by cannon, I must therefore desire your lordship to send me 20 barrels of powder more, with some hand grenades, and if you please to order a mortar piece, I shall be able to do his majesty better service, and your lordship will much oblige,

"Your humble servant,

"William Vavasour."

I beseech your lordship to send some more cannon bullets.—*Harl. MS.* 4713.

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1644. Sir Walter Erle appointed lieutenant-general of the ordnance. Thomas Heselrige appointed clerk of the deliveries.

8 Apr. A warrant from his majesty to Sir John Heyden, kt. lieutenant-general of the ordnance, for paying the train of artillery.

25 Apr. His majesty's warrant to Henry Lord Percy, general of the artillery, or the lieutenant-general of the ordnance, or any other whom it may concern, to send from the magazines 150 shot for a minion piece, 2000 lbs. of match, and 2000 of bullets to the garrison in Reading.

8 Oct. To Sir Ralph Hopton, general of the artillery, and to the officers of the same, to deliver powder and bullets for the garrison at Milbrooke, and Mount Edgecombe.—*Harl. MS.* 6802.

1645. A list of the officers belonging to the train of artillery in the Parliamentary army, commanded by Sir Thomas Fairfax.

Lieut.-general Hamond .....lieut.-general of the ordnance.
Captain Dean .....comptroller of the ordnance.
Master Hugh Peter .....chaplain to the train.
Peter Manteau Van Dalem .....engineer-general
Captain Hooper .....engineer extraordinary.
Eval Tencene .....chief engineer.
Master Lyon, Mr Tomlinson .....engineers.
Master Francis Fuvin .....master-gunner of the field,
Master Matthew Martin .....paymaster to the train.

Colonel Rainsborow
Lieut.-colonel Bowen
Major Done, „ Crosse, „ C. Crosse } slain at Sherburn
„ Edwards
Captain Edwards
„ Drury
„ Dancer
„ Horsey, slain at Sherburn
„ Creamer, wounded at Sherburn
„ Sterne, slain at Bristol
Captain-lieutenant Flemming, slain at Sherburn
Colonel Weldon, now Lelburne
Lieut.-colonel Kempson

Major Masters
Captain Peckham
„ Fenton
„ Franklin, slain at Exeter
„ Holmes
„ Dorman
„ Tolhurst
„ Munday, died in the west
„ Welden
„ Kaine
Master Phips, commissary of ammunition
Mr. Thomas Robinson, commissary of draught horses
Capt-lieuts. Desborow, Brent ... } of firelocks
Captain Cheese, of pioneers

1646. William Billers appointed clerk of the deliveries.—*Ordnance Quarter Book.*

1649. Richard Wollaston appointed master-gunner of England.—*Ordnance Quarter Book.*

1650. Major-general Harrison appointed lieutenant-general of the ordnance.

Letter from Cromwell to the speaker of the House of Commons, dated Edinburgh, 24th December, 1650.

"It having pleased God to cause the castle of Edinburgh to be surrendered into our hands this day about 11 o'clock, I thought fit to give you such account thereof as I could, and the shortness of time would permit. I sent a summons to the castle upon the 12th instant, which occasioned several exchange of returns and replies; which for their unusualness I also thought fit humbly to present to you. Indeed, the mercy is very great and seasonable. I think I need say little of the strength of the place, which, if it had not come as it did, would have cost very much blood to have attained, if at all

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to be attained; and did tye up your army to that inconvenience, that little or nothing could have been attempted whilst this was in design, or little fruit had of anything brought into your power by your army hitherto; without it, I must needs say, not any skill or wisdom of ours, but the good hand of God hath given you this place.

"I believe all Scotland hath not in it so much brass ordnance as this place. I send you here enclosed a list thereof, and of the arms and ammunition, so well as they could be taken on a sudden, not having more at present to trouble you with, I take leave, and rest.

"Sir,

"Your most obedient Servant,

"O. CROMWELL."

A list of ordnance, &c. in the Castle.

Brass Pieces.—5 French cannon, or cannon of seven, 9 Dutch half-cannon or 24-prs., 2 culverins, 2 demi-culverins, 2 minions, three 3-prs., 2 falcons, 28 drakes, called monkeys.

Iron Guns.—The great murderer, called "Muckle Meg," 4 cannon, 10 drakes, called monkeys, 2 petards. About seven or eight thousand arms, between three and four score barrels of powder, and great store of cannon shot.

1651. At the surrender of Stirling Castle amongst the guns found were eleven leather guns, as reported by Colonel Moncke, lieutenant-general of the ordnance to the lord-general Cromwell.

1655. John Hooker appointed keeper of the small arms.

1656. Lewis Awdeley appointed clerk of the ordnance.

1660. Sir William Compton, kt. appointed master-general.

Colonel William Legg	ditto	lieutenant of the ordnance.
Francis Nicholls	ditto	surveyor-general.
Edward Sherburne	ditto	clerk of the ordnance.
Richard March	ditto	storekeeper to do.
George Clerk	ditto	clerk of the deliveries.
Matthew Baylie	ditto	clerk to the master-general.
Colonel James Weymes	ditto	master-gunner of England.

6 Nov. In the House of Commons, Sir Wm. D'Oiley reported from the committee for disbanding the army, what progress had been made in that service, in which the two following items as belonging to the ordnance are mentioned, viz.—

(1) *In England,* general officers with the train £1642. 13*s.* 6*d.*

(2) *In Scotland,* general officers and train £797. 11*s.* 3½*d.*

1661. Sir Bernard de Gomme chief engineer.

52 gunners { 3 gunners at 1*s.* each per diem. / 1 do. 8*d.* / 48 do. 6*d.* } paid in the March Quarter Book at the Tower.

1662. { 13 gunners at 1*s.* each per diem. / 5 do. 8*d.* / 72 do. 6*d.* } paid in the December Quarter Book at the Tower.

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28 Aug. Warrant from the Earl of Peterburgh appointing Captain Martin Beckman, engineer-general of Tanger.

1664. 21 Oct. John Lord Berkeley, Sir John Duncombe, kt. Sir Charles Chicheley, kt. } the appointment of the master of the ordnance held by commission.

Captain Martin Beckman appointed fire-master; Richard Batchler appointed keeper of the small arms; 98 gunners paid at the Tower.—*In December Quarter Book.*

1666. Captain Valentine Pyne appointed master-gunner of England.

1668. Thomas Benet appointed clerk to the muster-general.

Charles II. 1669. 18 Mar. Nature of ordnance in the service, taken from an ordnance return, shewing the remains at the Tower, and the several magazines, castles, and forts.

Brass Ordnance.

Cannon of 8	Sakers
Cannon of 7	Mynion
Demi-cannon	3-prs.
24-prs.	Falcon
Culverings	Falconett
12-prs.	Brass baces of 7 bores
Demi-culverings	Inch and ¼ bore, and 7 other sizes
8-prs.	
6-prs.	

Iron Ordnance.

Cannon of 7	6-prs.
Demi-cannon	Saker
24-prs.	Mynion
Culvering	3-prs.
12-prs.	Falcon
Demi-culvering	Falconett
8-prs.	Rabonett

Brass Mortar Pieces.

18½-inches	7¾-inches
16½ „	7¼ „
13¼ „	6½ „
9 „	6¼ „
8¾ „	4½ „
8 „	4¼ „

Iron Mortar Pieces.

12½ „	4¼ „

Harl. MS. 4244.

Dec. Jonas Moore appointed surveyor-general of the ordnance.

1670. 4 June His majesty's warrant, appointing Sir Thomas Chicheley master of the ordnance, with the profits of the office, &c. in as full a manner as Ambrose late Earl of Warwick, or Sir Phillip Hoby, kt. or Sir Richard Southwell, kt., Sir Phillip Sidney, kt., Robert late Earl of Essex, Charles late Earl of Devon, George Lord Carew, Howard Lord Vere, Montjoy Earl of Newport, or the said Sir William Compton, or any other persons, &c.

Richard Beck appointed clerk to the master-general.

George Wharton appointed by king's warrant a clerk of the deliveries of all, and all manner of ordnance, artillery, ammunition, and other necessaries, &c., and enjoy the same in as ample manner as Bryan Hogg, George Hogg, John Lynwray, Sir Robert Johnson, Edward Johnson, Henry Johnson,

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Thomas Eastwood, and George Clarke, or any of them, &c. &c.—13 March. *Harl. MS.* 4713.

7 Dec. David Walter, Esq. appointed lieutenant of the ordnance.
Samuel Fortsey appointed clerk of the deliveries. 103 gunners paid at the Tower.—*December Quarter Book.*

George Wharton appointed treasurer and paymaster, it being improper for the lieutenant-general as a military officer to be treasurer, and receive poundage out of the large sums that would then pass his hands. Before this time the master-general and principal officers had the power of selling the places under them, and claimed the old guns and stores as their perquisites.

1671. His majesty granted the old store-house and wharf at Woolwich, called the gun wharf, to Sir William Prichard for the sum of £2957.
Ernest de Reus, fire-master to the office of ordnance.
The gunners paid quarterly at the Tower as the previous year.
Charles Beaumont appointed clerk to the master-general.

1671. 4 Sept. An account of the natures, weights, and lengths of 41 pieces of new iron ordnance, being weighed, and proved, from Mr Westerne, one of his majesty's founderers.

Cannon of 7, of 10 foot.		
cwt.	qrs.	lbs.
63	3	21
64	0	21
62	2	7
62	3	7
62	0	21
65	2	21
61	0	21
63	3	7
62	3	21
62	1	21
63	1	21
61	0	21
62	3	7
64	2	21
63	1	14
62	2	21
63	2	7
64	0	21
Ditto of 9½ foot.		
60	1	0
59	1	21
59	3	21

cwt.	qrs.	lbs.
59	0	21
57	3	21
59	0	7
59	3	21
54	0	21
Culverings of 10 foot.		
43	2	7
44	1	21
Demi-culverings of 10 foot.		
36	2	7
36	0	21
36	2	21
36	1	21
36	0	21
36	2	14
29	3	21
36	0	3
36	1	21
35	0	21
35	2	14
37	0	21
36	0	21

1672. Sir George March appointed storekeeper to the ordnance.

Estimate of the storehouse to be set up at Woolwich for receiving fire-works. The building to be 70 feet in length by 20 wide, with doors, locks, and all materials £125.

An estimate for the carriage of guns, carriages, shot, &c., from the office of his majesty's ordnance at the Tower place, near Woolwich.

Loading and drawing shot from the old yard to the new, per load 1*s.* 4*d.*
Drawing guns from the old yard to the Warren ..... } Guns { 30 cwt. and upwards.....4*s.* 0*d.*
30 „ and under .....2*s.* 6*d.*

2 Apr. The following warrant contains the first notice of bayonets being introduced into the English army.

"Our will and pleasure is, that a regiment of Dragoons which we have established and ordered to be raised in 12 troops of fourscore in each

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besides officers, who are to be under the command of our most dear and most intirely beloved cousin, Prince Rupart, shall be armed out of our stores remaining within our office of ordnance, as followeth; that is to say, three corporals, two serjeants, three gentlemen of arms, and twelve soldiers of each of the said 12 troops are to have, and carry each of them one holbard, and one case of pistols with holsters, and the rest of the soldiers of the several troops are to have and to carry each of them one matchlocke musket, with a collar of bandileers, and also to have and to carry a *bayonet* or great knife, that each lieutenant have and carry one partizan, and that two drums be delivered out for each troop of the said regiment, &c.

"By his majesty's command,

"ARLINGTON."

"To Sir Thomas Chicheley,
Master-general of the ordnance."

1673. His majesty's warrant appointing Sir Thomas Chicheley master of the ordnance and armoury.

The master-general and board order Captain Valentine Peyne, master-gunner of England, £30 for his extraordinary attention and pains in assisting in taking the general remains of all the stores within the office of his majesty's ordnance.

Jonas Moore, Esq. comptroller of his majesty's train of artillery will order into store the brass ordnance issued for the artillery company's public exercise at the artillery garden, viz.—

Brass ordnance on travelling carriages,

Two sakers, four 3-prs., one 8-in mortar.

Captain Valentine Peyne, master-gunner of England, is allowed to charge 1*s.* 6*d.* a day from the 9th August to 11th September for the gunners employed in mounting guns at Woolwich.

11 Nov. The Board direct there may be issued for the proof of ordnance at Woolwich in Mr Brown's yard, gun foundry, viz.—

Round shot for, with powder, match, &c.

12 cannon	3 demi-culverins
4 demi-cannon	16 sakers
23 culverins	1 3-pr.

Jonas Moore, surveyor-general, made Sir in this year.

1674. 2 May. His majesty's warrant to Sir Thomas Chicheley, kt. muster-general, appointing him also master-general of the ordnance in Ireland, void by the death of Sir Robert Byron.

ditto. His majesty's warrant to Sir John Chicheley for the master of the ordnance and armoury, after his father, Sir Thomas Chicheley.

Edward Conyers appointed storekeeper to the ordnance.

Thomas Langley appointed second clerk to the muster-general.

1676. 19 May. "Sir,

"His majesty having appointed a rendezvous of several of his majesty's horse and foot guards in Hyde Park on Tuesday next, being the 23rd of this instant, I desire you to cause eight field pieces, viz.

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4 demi-culverins and 4 sakers brass ordnance, and two mortar pieces, with all their carriages, and furniture thereunto belonging, together with two wagons, two tumbrells, and 4 tents attended with a competent number of gunners, fifty pioneers, with their respective officers in their best equipage, to attend the exercise of the said forces on the day above mentioned, and that they fail not to be there by eight o'clock in the morning at farthest.

"I am,

"Your most humble servant,

"MONMOUTH."

"To Sir Thomas Chicheley,
Master-general of his majesty's ordnance."

1677. George Legg appointed an assistant in the Board of ordnance with a salary of £300 per annum.

21 May. His majesty's warrant granting Captain Richard Leake the master-gunnership of the Tower of London and Kingdom of England.

21 Nov. His majesty's warrant to John Brown, Esq. to be founder of ordnance, &c.

George Wharton, treasurer and paymaster, made Sir in this year.

1678. His majesty's warrant appointing Colonel George Legg, general
1 May. of the artillery, belonging to our army now, in the Spanish Netherlands, and to carefully discharge the trust of general of our artillery appertaining to the same, &c.

Charles Beaumont appointed keeper of small arms.

1679. The quarter books of the office of his majesty's ordnance, contain the allowance and wages to the several officers, clerks, artificers, labourers, and gunners daily, attendent and employed in the said office; also the wages, salaries and allowances of the several storekeepers, employed by the said office at Woolwich, Chatham, Sheerness, Upton Castle, Windsor Castle, Portsmouth, Berwick and Hull; also to Captain Richard Leake, master-gunner of England, for exercise of schollars to shoot in great ordnance at the artillery ground.

To Captain Hugh Kelly for his attendance on the proof of ordnance and powder.

To Jonas Moore, Esq. for his better encouragement in the study of mathematics, especially in the art of fortification, gunnery, and artillery, and such other parts thereof as may most conduce to his majesty's service, as per warrant, 1st October, in the 24th year of his majesty's reign after the rate of £100 per annum.

To John Linger, firemaster as by warrant 11th Feb. 1675.

23 June. Sir John Chicheley, kt., Sir Wm. Hickman, kt., Sir Christopher Musgrave, kt., to perform the duties of master-general by commission.

1 July. George Legg appointed lieutenant of the ordnance, *vice* David Walter, Esq.

Thomas Langley appointed clerk to the master-general.

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July Quarter Book. An allowance to George Legg, Esq. in consideration, that the manner house in little minories, heretofore appropriated to the place of lieutenant-general of the ordnance is alleniated from the same place, without any benefit or satisfaction made him.

To Richard Wharton, gentleman, for his encouragement to travel into foreign parts, and perfect himself in the studies of mathematicks, especially in the art of fortification, and other parts thereof, as may render him capable to serve his majesty for the future as an engineer, as per warrant 1677.

To John Tinker, for his invention of a new way of shooting hand granades out of a small hand mortar piece, which may prove of great advantage to his majesty's service. Warrant dated 13 July, 1678.

To Sir Bernard de Gomme, kt., his majesty's chief engineer. Warrant dated 12 June, 1669.

Sept. Francis Smith, gentleman, Captain John Piggott, for attendance on the proofs of ordnance and powder.

13 Sept. Demand of Sir Bernard De Gomme for new carriages to be placed within the royal citadel of Plymouth.

31 ship carriages, 25 standing carriages, and the repairs of the old carriages, in number 16, according to the note herein enclosed, and 7 carriages for St Nicholas island near Plymouth.

New Fashioned Ship Carriages for Platforms.

	Carriages.		£	s.	d.	
Whole culverings drake	11	at	3	15	0	Not painted.
Demi-cannon drake	2	„	4	10	0	
Demi-culverings drake	5	„	3	0	0	
8-prs.	3	„	3	0	0	
6-prs.	5	„	2	18	0	
Sakers	2	„	2	18	0	
5-prs.	1	„	2	18	0	
Minions	2	„	1	18	4	
	31		101	5	8	Amount making not painted.

Standing Carriages.

	Carriage.		£	s.	d.	
Whole culverings	8	at	11	0	0	Not painted.
12-prs	2	„	11	0	0	
Demi-culverings	9	„	9	0	0	
6 and 5-prs.	4	„	7	0	0	
Sakers	2	„	7	0	0	
	25		223	0	0	Amount making not painted.

Standing Carriages for St Nicolas Island.

	Carriage.		£	s.	d.
Sakers of 10 ft. long	1	at	7	0	0
Sakers of 9 „	1	„	7	0	0
Demi-culverings of 9½ ft. long	1	„	9	0	0
„ „ 10½ „	1	„	9	0	0
„ „ 10 „	1	„	9	0	0
„ „ 9 „	1	„	9	0	0
Sakers of 8½ ft. long	1	„	7	0	0
	7		£57	0	0

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Abstract.

	£	s.	d.
Ship carriages	101	5	8
Standing carriages	233	0	0
„ „ St Nicholas Island	57	0	0
Repairing old carriages	121	0	0
	£512	5	8

1682. 8 Jan. His majesty's warrant appointing George Legg, Lord Dartmouth, master-general of the ordnance.

ditto Sir Christopher Musgrave appointed lieutenant of the ordnance.

His majesty's warrant (reciting that abuses had crept into the garrison), puts all the master-gunners in Great Britain under the authority of the muster-general, authorizing him to examine them, and turn out such as are unfit for service, notwithstanding they might have been appointed by patent from the exchequer.

17 Mar. Estimate by Sir Bernard De Gomme, his majesty's chief engineer, and assistant surveyor of the ordnance for dividing of the great house at Woolwich, &c., and repairing and altering the smith's shop there.

Apartments for the Storekeeper.

A parlour, kitchen, pantry, three rooms above stairs.

A hall common to the storekeeper, and Captain Leake, master-gunner of England.

Apartments for Captain Leake.

2 parlours, kitchen, pantry, 2 bed rooms.

For the lieutenant of his majesty's ordnance.

A great dining room, to be kept for the use of the officers of the ordnance, and in their absence Captain Leake shall have the use of the said dining room, and the closet; a great bed-chamber with a closet to be for the lieutenant of the ordnance; a little room for his servants; the third story for the servants of the storekeeper, and Captain Leake's family; a stable for Captain Leake's horses; a brewhouse to be common to the two families; fitting up part of the smith's house for 12 gunners; three rooms, each to contain four gunners.

2 June. An order for the saltpetre storehouse to be repaired.

1683. 24 Jan. His majesty's warrant for building a storehouse for the train of artillery, with the carriages and all other necessaries, and a new armoury for the use of the guards in St James's Park, on the south side of Spring Garden wall, according to a draught annexed and approved, for the so doing this shall be your warrant, &c.

CHARLES R.

1683. 25 July. Right trusty and well beloved councellor,

"We greet you well. Whereas we have taken into our princely consideration and care the great consequence and necessity of preserving the state of our artillery, munition, arms, and of all other the habilia-

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ments and equipage belonging to our magazine royal within the office of our ordnance, which hath heretofore with much providence and wisdom of our predecessors been instituted, endow'd and supported, as a member highly importing the safety and defence of our dominions as well by sea as land. We have therefore thought it requisite and necessary for the better conservation of our said office, and for the good of our service therein, that instructions should be forthwith drawn for the government of the office of our ordnance, under our master-general thereof, expressing as well the particular and proper dutys of each principal officer severally, as the common dutys of them jointly, in the general management of our said office, with the dutys likewise of each inferior officer, minister, and attendant, thereto belonging. And for as much as you have in obedience to our commands presented to us a book containing the following rules and instructions of our royal allowance and establishment; we having taken the said instructions into our princely consideration have thought fit to approve, ratify, and confirm the same under our royal sign manual upon every leaf of the said book, and do hereby declare our will and pleasure to be, that the said instructions so by us approved."

NOTE.—The continuation of this subject will be found at Vol. II. p. 120, *ante*.

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Desultory Notes at Takoo. By an OFFICER of the Siege Train.

THE story of the attack of Takoo will have been long since told in so many shapes in England, that its repetition here would be tedious; and the more so as the observations of an officer acting in a subordinate regimental capacity, and hard worked in his own sphere, are not likely to add much to the information which will certainly be supplied by those who had the opportunity of a more extended view. It is possible however that a few stray notes taken on the spot, and having especial reference to the Chinese artillery, may include a few matters as yet untold, and have their interest for professional gunners at home.

The north fort, *par excellence*, of Taku—that attacked and taken on the 21st August, 1860, by the 2nd Division of our army under Sir Robert Napier—was an irregularly square earthwork, of probably about 80 yds. wide; a rampart of about 10 ft. high, surmounted by a slight parapet, ran round it; within which, on the side nearest the river Peiho, a huge solid cavalier of earth was raised, on the summit of which was a terreplein, and very thick parapet, with embrasures for three guns, looking river-wards. The cavalier was 30′ or 40′ high; it constituted the really important part of the work, the outer wall of the fort being scarcely worth the name of a defence, *originally*. The fort mounted about 30 guns of all natures; the three on the cavalier being two splendid brass guns of about 8-in. and 32-pr. bore respectively, and an iron 32-pr. of European manufacture. The guns around the walls were all smaller, some very good, short, serviceable pieces; others, of about one pound bore, made of longitudinal strips of iron, with transverse hoops shrunk on outside; a few of wood, covered with ox-hide, and bound with iron. These latter were probably for saluting, or for firing the light-balls with which the Chinese constantly favoured us at night. The guns on the river-ward wall were casemated, and of good size, some of them European. It was evident that the forts, which were all constructed on the same general plan, were intended solely as a defence for the mouth of the river; the rampart running round the back of the fort had been at first little more than a boundary, and remained in the same state in the other works on both banks; after our army disembarked at Pe-tang, however, the Chinese had commenced to strengthen their fortifications, and the outer parapet of the fort taken by us had been converted into a defence of very great strength by having stout piles driven in rear of it, each fastened to the next by an iron clamp. Our 8-in. and 32-pr. shell made no great impression on this; it would doubtless have been demolished had the bombardment lasted 24 instead of 1½ hours; it stood, however, several rounds and some salvoes from the siege guns, almost unharmed. The parapet of the cavalier was about 12′ thick, composed entirely of rows of piles clamped to each other, the interspaces being filled with rammed earth; it would have required a heavy and continued fire to even seriously injure this. The parapet only protected the river side of the cavalier; it was quite open in rear, towards the land, so that when the Chinese turned the three guns on it towards the assailants, they worked them completely without cover, and no Europeans, even no British, could have stood to their guns better than they did, under such disadvantages; exposed, in the fullest sense of the word, for nearly two hours to a converging *feu d'enfer* from some fifty of

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the best guns in the world, to make no mention of the Enfield rifles and *carabines à tige*.[1]

A wet ditch of about 12′ or 15′ wide ran round the fort; outside it, and between it and the rampart, the ground was thickly planted with pointed bamboo spikes, about 2′ long, firmly fixed in the ground. These looked more serious obstacles than they were afterwards found. The ditch was crossed by a *practicable* drawbridge in front of the gate. On the river side, two additional wet ditches had been made; the interspaces being full of bamboo spikes. At the furthest ditch was an abattis of closely-branching trees, among the twigs of which bells were hung, so as to give the alarm in case of a night attack. No *trous de loup*, mines, or any of the other *diableries* that we are accustomed to charge the Chinese with, were to be seen.

The main magazine was situated at the foot of the cavalier, in an excellent position, looking at the fort as a river defence; but quite exposed from the land side. It appeared to have been similar to those in the other forts; a low square building of piles and mud, with a flat roof—a most inviting object for a mortar shell. The powder was stored with some care, in large wooden boxes covered with ox-hide. The credit of having blown up this magazine—although no one was aware of its existence previous to the explosion—was hotly contended for in camp. From the position of the magazine, and other circumstances, I should rather think the aggressor was a shell from the 8-in. mortar battery (which, by the way, as the first movable mortar battery, is a great success), or from the heavy siege guns; but as above fifty guns and rockets were in hot play on the little fort at the moment, I should be sorry to venture more than a guess at the truth.

It is worth mentioning that the general disposition and mode of construction of the Takoo forts is exactly similar to a plan of defence for the mouth of a river given in a very curious illustrated Chinese book on fortification and other military matters, found at Sin-ho by Asst.-Surgeon Lougheed, R.A.

The garrison of the captured fort could not have been much over 500 men; I saw over 200 of them buried. Most of the latter were killed by the old-fashioned shell, with its rending, tearing bursting charge; very many by the Enfield bullet; a few only were found in the debris of the magazine. I have heard from a Chinese officer who commanded in one of the south forts (the generalissimo San-ko-lin-sin, being in another), that the great damage was done by the large shells. He also stated that a magazine in one of the *south* forts, which was also blown up, owed its destruction to a shell from one of the gun boats.

Most of the embrasures of the cavalier and casemates were provided with mantlets of bamboo and ox-hide, capable of being raised by a rope and pulley, and lowered when the gun was run back for loading. Great stress was laid on those mantlets in the accounts of the unfortunate affair at

[1] A reference to the despatches scarcely bears out the statement that as many as "fifty" guns were played at one time upon the single fort in question; the fire of the guns in action having been distributed about the different forts and positions which were the objects of attack. No doubt, however, the author is perfectly correct in describing the fire as a *feu d'enfer*.—V. D. M. Actg. Sec., R.A.I.

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Takoo in 1859; but it is almost needless to say that there is no "treachery" in hanging a mantlet in front of your gun—or to be more guarded, that although it may be treacherous in a Chinese to do so, it would be merely professional in an English or Russian gunner. I may mention that, seeing one of those mantlets lying on the ground doubled over itself in one of the embrasures of the cavalier, I had the curiosity to raise up the upper portion, when I found the greater number of the segments of an Armstrong shell lying in the fold.

No praise can do more than justice to the resolute behaviour of the Chinese artillerymen at Taku. They were mostly fine looking, well-made fellows; some with fine handsome features, bearing even in death an expression of cheerful resolution. They had probably been paid shortly before the action, as our men found small ingots of silver on the persons of several. I have heard it said that some of them were found *tied* to the guns; I venture, however, to consider this a mistake, probably caused by some dead body being entangled in drag-ropes, fixed to most of the large carriages to aid in traversing; I saw nothing of the kind myself. The dead, when collected, were thrown into the pit formed by the explosion of the magazine, and covered up. Some of us would have wished, had time served, to have raised a soldier's memorial over them as a tribute to a brave enemy; the only monument in the fort, however, was a wooden cross, surrounded by the ingenuity of our allies by a little paling, tasteful, though of the simplest materials, and bearing for legend:—*Ici reposent cinq soldats Françaises, morts au champ d honneur, le* 21 *Août*, 1860.

The carriages of the large guns on the cavalier were of the "garrison" model, without trucks, moving on a central pivot, and traversed by means of ox-hide ropes attached to small capstans placed between the guns. Sponges (made like an ordinary mop), rammers, shot, shell, hide-covered powder boxes, vessels of water for washing the sponge, lay all around. The shot and shell was of small calibre compared with the gun, allowing far too much windage, as is invariably the case in China. A notable advance in gunnery was a *graduated quoin*, with which many of the guns were supplied; it had small grooves on the upper surface, corresponding with lines and figures on the side. This is a marked improvement in artillery matters, of which we may some day feel the effect; the *line* of the Chinese fire is generally very good, the *elevation* imperfect. The shells also exhibited great improvements; they were not badly cast, and were supplied with wooden bottoms, screwed on to the shell. The fuzes were of most curious construction, consisting of two hollow cylinders of brass, one fitting into the other, and both into an outer cylinder or case. Quick match, composed of mealed powder in a thin wrapper of paper, passes down through the central cylinder, leaving one end exposed at the top for priming; passing through an opening at the bottom, the other end winds *up* a screw-shaped groove on the exterior, when the second cylinder is put on, and the match then winds *down* a similar screw on its exterior; the outer case then goes over all, through an opening at its bottom the match communicates with the burster. The fuze is *screwed* firmly into the shell, a small cap protecting the top of the match until required for loading. This length of match will burn for some seconds, and allow of a tolerable range; it is not adapted for use as a time-fuze. Some of the Chinese shells burst in good time, but the majority

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exploded after a very short range; none did any damage. Most of the Chinese guns were on some sort of carriages; several of the smaller ones, however, lay on the ground and were fastened by stakes in front and rear of each trunnion, lashed to each other and to the gun. At Sin-ho and elsewhere, rudimental travelling carriages were found, consisting of an ordinary carriage lashed on to a cart. On some of these the gun carriage was made double, so as to hold two small guns, the trunnion holes in the centre being common to both. Had the other Taku forts resisted, trial would have been made of the Chinese guns, manned by English gunners, against their old masters; since as soon as the escalading parties were actually on the wall—after which, as at Canton, there was no resistance except a few musket shots—Captain Beddingfield, R.A., with one of his officers and a dozen men, volunteered to enter the fort, laden with 32-pr. shell and cartridges, and other requisite articles, for the purpose of turning the guns in the cavalier on the south forts. The guns were turned round, laid, and all ready, when a Chinese officer (I cannot write that stupid Portuguese word *mandarin*) came in to surrender.

The weapons used by the Chinese were swords, spears, matchlocks, and jingals, similar to those at Canton. Numbers of bows were found, and several curious cross-bows, quite new, made with a chamber to hold six bolts, which could be shot in succession without reloading. None of the weapons—except some of the ordnance—were European. Some case shot, very similar to the service pattern, was found, and may have belonged to the gun-boats sunk in 1859. A fly leaf of a book on naval gunnery was in one of the casemates, covered with memoranda in Chinese.

Light-balls, and various fireworks, were discharged by the Chinese towards our working parties, during the night previous to the assault; but their range was only sufficient to shew the Chinese to us; some of them were very beautiful as fireworks. Great bonfires were lit, on the cavaliers, to enable the enemy to see us; they were not, however, very effective.

In the interior of the fort were disposed in regular order the Chinese soldiers' huts. These were made of long fascines of straw bent in a semicircle, both ends sunk in the ground. A number of such, fastened to each other, composed the hut, the whole being then plastered over and made weatherproof with mud. The ends of the hut were provided with a door and window of woodwork and oiled paper. Similar structures were used in the permanent entrenchments at Sin-ho and Tang-ku, and were by no means uncomfortable abodes. Outside each was a small cooking place; the names and description of the inmates, posted on a wooden tablet, hung in each hut. Regular store-houses and magazines, ice-houses, and even latrines, existed; the whole, though not exactly in conformity with our notions, showed no want of discipline or civilization.

Our total of casualties were much the same as at the capture of Canton; at the latter place, however, the officers suffered more severely. One little incident at Takoo, not discreditable to the British soldier, may be mentioned. One of our men was in the act of offering a drink to a dying Chinaman, when the latter, collecting all his strength, made an ineffectual cut at the soldier with his sword—under the influence, doubtless, of feelings of wounded pride and patriotism that it would be ungenerous to criticise too harshly. The Englishman, naturally exasperated, was preparing to despatch

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his enemy with the bayonet, when at the moment a comrade came up, and in the gruff accents of a true Briton, cried out "Let the poor beggar be, Bill; there ain't much life left in him." *Let be* the Chinaman was, accordingly, though this manly forbearance did not prolong his life above a few minutes. Notwithstanding this and other similar cases, many fugitives were *unnecessarily* slain in the flush of success by the assailants; so difficult is it to divorce from war, even in the nineteenth century, that *ferocity* so abhorent to the true soldier. Our soldiers are yet surpassed by none in the world in chivalrous feeling and mercy towards the conquered. We may fairly hope that the unparalled efforts now being made to elevate and educate our men, will still further strengthen and develop such qualities, and that the encomium passed on one of our naval heroes may apply to all fighting men ashore and afloat:—

> "A furious lion in battle—and so let him;
> But duty appeased, in mercy as a lamb."

It would have opened up many sources of curious and interesting information on Chinese military affairs, had our officers been to any extent acquainted with the language. All official business in China is done on paper; and in all the military stations from which we dislodged the Chinese, letters, states, and returns were found in the greatest profusion. Books on military affairs, full of extraordinary wood-cuts, were not uncommon. Although, however, the advantages of acquaintance, even to a slight extent, with the language of this great and little-comprehended nation, is obvious; and although the *spoken* court and northern dialects—or even the written language to a certain extent—present no insuperable difficulties to ordinary quickness and industry; still, without some systematic encouragement such as is given to the culture of the native tongues of India, a young officer cannot be expected to devote his time and money to the acquisition of a language, which, especially since the periods of foreign service have been curtailed, is not likely to be of any service to him personally; still the practical monopoly of direct communication with the Chinese by a few individuals is a serious evil, and is one cause of the want of good understanding between the countries. The encouragement of the study of the language by officers and civil servants generally would be of great value; as would also—if in alluding to it I am not laying myself open to the rebuke of *Ne sutor ultra crepidam*—the establishment of schools for the Chinese at our chief stations, where the English language, and strictly secular information regarding our country, arts and sciences, might be offered to this people, who are most intelligent, curious, and anxious for this very knowledge, although not prepared to renounce their own religion and nationality as a preliminary to acquiring it.

R. E. C.

TIENTSIN,
December, 1860.

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The Royal Artillery at Canton. By an OFFICER of the Royal Artillery.[1]

No. 3. Transport of Mountain Ordnance.

THE transport of the light 3-pr. guns and 4⅘-in. howitzers of which the effective artillery in the south of China in 1857-58 and 59 consisted, was at first performed by the gunners of the batteries; an arrangement which, however faulty and detrimental to the artillery service, was at least practicable during the cold weather which attended the opening of the campaign; but which became simply impossible when the hot season set in, and of which the unfortunate results were painfully apparent in the skirmish near the White Cloud Mountain in June, 1858. Immediately after that occurrence, owing to repeated suggestions from the commandant of artillery (Colonel, now Brigadier-General W. T. Crawford, C.B.), it was decided by the major-general commanding (Sir Charles Van Straubenzee, K.C.B.), that on future marches Chinese coolies should be attached to the artillery to perform the necessary transport, leaving the gunners free for their own proper duties. A similar arrangement had been made with the former commandant of artillery, Colonel F. Dunlop, C.B. R.A., but owing to circumstances had not been carried out. The light ordnance and stores were in consequence for the most part carried by Chinese coolies during subsequent operations, terminating with the affray at Shek-tsing in January, 1859, with unquestionable advantage to the service.

There were, however, many objections attaching to transport by coolies:—the enormous length of the line of march on narrow causeways; its consequent unmanageableness; the difficulty of communicating intelligibly with the Chinese; the liability of portions of equipment, when subdivided into coolie loads, to become mixed or mislaid; and the fact that the Chinese so employed, and on whom everything depended, were naturally hostile to us; and however mercenary by nature, or faithful (as they undeniably were) in time of success, could not be implicitly depended on in the contingency of a reverse of fortune. Considerations such as these rendered artillery officers anxious to improve still more the method of transport; and as ponies, at first very scarce, became obtainable in greater numbers, Colonel Crawford applied to have a few attached to the artillery, in order to try their capabilities experimentally. The attention of the major-general was at this time, however, directed to the formation of a mounted police corps, composed principally of men from the infantry and marines, for the supervision of Canton and the adjacent country; and as no ponies could in consequence be spared for the artillery, the decision of the question was deferred until 1859.

The Canton ponies are small and hardy, delicately shaped, more like miniature horses than ponies; docile, sagacious, and sure-footed in the extreme; and as the light ordnance had been sent from England fitted for pony draught and provided with harness, it only remained to be seen whether draught of any kind was practicable over ground of such peculiar contour as that about Canton. *Primâ facie*, it seemed probable not; as the only vehicle used by the natives is a sort of one-wheeled barrow. The

[1] For Articles 1 and 2 on this subject, see OCCASIONAL PAPERS, Vol. I. pp. 151, 219.

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country consists of a succession of hills, the few level spots (in the valleys) being covered with villages, tanks, or bamboo groves. The roads are either causeways composed of slabs of stone 4 or 5 ft. long, by 12 or 18 in. wide, laid down side by side perpendicular to the direction of the road, or mere beaten footpaths winding round the bases of hills; the latter, where they exist being often wider and more practicable than the made roads. The whole internal traffic of the country being, however, performed by coolies in single file, carrying between them the burden slung on a bamboo resting on their shoulders, regularly-constructed roads are scarcely necessary and do not always exist; for military operations it must be frequently necessary to take a direction "across country," i.e. right over the hills, and through the cultivated grounds in the valleys—the latter being inundated, either by the rains, or artificially for rice growing, during a great part of the year. The hills are badly suited for artillery or other draught, the surface being a loose slippery soil, a granite detritus, and the difficulty of traversing this being increased *ad infinitum* by the mode of interment of the dead adopted in South China. For miles around Canton, the hill sides are thickly covered with graves, which consist of semicircular spaces of from 3 or 4 ft. radius upwards, levelled in the slope of the hill; the area being generally covered with a hard cement, and the sides and back revetted with masonry; an underground cavity in the highest part being made for the coffin, and afterwards closed up. The number of those graves may be inferred from the hills having been the burial grounds for generations of one of the most populous cities in the world; and when it is considered that their profile is thus made to consist of a series of "drops" of all sizes and degrees of irregularity, the original slope, generally considerable, being only left at intervals where too rocky or hard to be dug up, it will be seen that the obstacles to the draught of wheeled vehicles are not slight.

At length in the autumn of 1859, some ponies were lent to the artillery from the police force, for the purpose of making this important trial, the management of which was entrusted to Captain Bedingfield, R.A. After a few days preliminary training to draught and fitting of harness, Colonel Crawford directed the first experiment to be made by sending a 4⅔-in howitzer, horsed, along a level pathway from the north-east gate of Canton to a hill known as the "Hog Back" or "Artillery Hill," about five miles north of the city, to return by the main stone road leading into the east gate. Captain Bedingfield, who had just arrived from England, having slightly mistaken the route, found himself a considerable distance to the westward of the Hog-back, and determined to perform the *experimentum crucis* by taking the gun to it straight across country; the intervening ground presenting no track or pathway, and including several hills of the description before referred to, some tillable ground, many banks and ditches, and a considerable brook; altogether as unfavourable a route as the artillery had ever been obliged to take. The trial was most satisfactory, although the gunners had on a few occasions to unship the gun and "fist" it over obstacles which the ponies were unable to surmount, every man came in fresh and fit for action; the gun had had fewer upsets than usually occured to it when dragged by hand over more favourable ground; the ponies were but slightly tired; the gain in time, manageableness and efficiency was most striking. A simple contrivance hit on by Captain Bedingfield and adopted on future

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occasions, rendered the success complete:—two long bamboos were lashed lengthwise to the howitzer, projecting considerably over the muzzle in rear (limbered up), forming a long lever by pressure on the ends of which a single man could relieve the wheel horse of the whole weight of gun and shafts, when any difficulty occurred. Short bamboos were also lashed across the breech and muzzle, to enable the detachment to support the gun, or lift it altogether off the carriage, when, as occasionally was unavoidable, either wheel was so much raised as to threaten an upset. By this simple but ingenious arrangement all remaining obstacles to the desideratum of horse transport were completely obviated; strong reports to this effect were made by Colonel Crawford and Captain Bedingfield, and on the former officer assuming command of the troops at Canton as brigadier-general, one of his first steps was the organization of a pony battery, which has proved most successful and is still in operation. It is not too much to say that had the idea been adopted earlier, during active operations, the service, and our prestige, would have gained by it; at the same time it must be borne in mind that previous to the experiment being actually made, there were many officers even of the artillery who doubted the possibility of any four-footed animal doing draught-work over such ground; and perhaps no horses in the world, except those indigenous to Canton, would have succeeded so completely in it.

The light ammunition barrows sent to China with the mountain ordnance were fitted only for man-harness; although the guns were adapted for pony draught—other disadvantages, to which allusion was made in a former paper, led to their being practically discarded in the re-organization of the light batteries. It was considered advisable to substitute for them pack ponies, carrying ammunition and stores for immediate use, the reserve being borne by coolies. For the ammunition ponies, a pack-saddle made after a pattern used in the West Indies, was suggested by Colonel Crawford; the frame-work consisting of two sets of tough slightly-curved wooden bars, crossing each other near their upper extremities, forming two X's, 2 ft. apart, which were kept together by a light iron bar passing through the crossings, on which the frames could open or close, so as to adapt themselves to horses of different size. Hooks for lashings were fitted into the upper arms of the X above the crossing, the arms, called "horns," were very short. Each side of the saddle was kept together by a couple of iron rods passing between the woodwork; a projecting iron *shoe* on which the burden rested, was fastened to the lower part of each leg of the frame; the load was further made fast to the hooks in the "horns" above. A stout pad kept the saddle from the horse's back. Two ammunition boxes made to fit the saddle, carried ten or twelve rounds of cartridge and shell, with small stores. A set of intrenching tools and spare sponge were lashed over the crossing, between the "horns;" a broad surcingle was made fast over all. This pack-saddle underwent a very severe experimental trial at Canton, and succeeded perfectly. A pony so laden went with safety over places where the man leading him could with difficulty keep his footing—for identification by old soldiers of the Canton division the direction of the first trial may be given:—from the Artillery Head Quarters to the summit of Kooniam-sahn, under the Chinese battery, and from that to Mud Fort, down the steep pathway on the west side of the hill; and afterwards from the Artillery Barracks along

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the slope towards the R.A. and R.E. Hospital, *below* the roadway. It is however probable that a small limber like that of the Madras mountain train (previously described) could travel anywhere with the gun, and would be found the most effective mode of conveying the necessary stores, &c.

The difficulty experienced at Canton in the locomotion of artillery led Major-General Van Straubenzee to think that a carriage formed on the model of one apparently used by the Chinese as a travelling carriage, might be found useful under particular circumstances. This officer had one constructed consisting, in general terms, of a small garrison carriage, as narrow as possible, provided, in place of fore-trucks, with a solid wooden wheel, without nave, narrower, and rather less than the wheel of the carriage in use; the place of the rear trucks was supplied by solid iron legs, fixed in the woodwork, and raising the rear of the cheeks off the ground. A pair of shafts or handles fitted into sockets near the rear of the carriage, projecting about 4 ft. behind it; by means of these, a man could either draw the gun, or push it before him like a wheelbarrow. This carriage, mounted with a 4⅘-in. howitzer, underwent a lengthened experimental and practical examination by a committee of Royal Artillery officers appointed by Colonel Crawford, consisting of Major Guy Rotton, Lieut. J. H. P. Anderson, and Lieut. and Adjt. R. E. Cane; but was not considered suited to European ordnance. The absence of naves rendered the motion so unsteady that it was difficult and dangerous for the shaft man to either pull or push it; their presence would have made it as wide as the ordinary carriage. From its narrow gauge, it was extremely liable to upset, carrying the shaft man over with it. On firing, the iron legs in rear of the carriage gave way at once, being driven up into the wood of the chee ; and from the sudden check thus given to the recoil, the gun and carriage turned over at each shotted round. Carriages of this model might be used with Chinese guns of heavy metal fired with weak slow-burning powder and a low shot, but could not resist the sudden recoil of a light brass howitzer, with good powder, and a shell of considerable diameter and little windage. Had it been found serviceable it would have had the great advantage (for the peculiar service) of being able to travel on a path broad enough for a single man, and would have been useful for short expeditions under particular circumstances, with which view alone the general directed attention to it; but few artillery officers who have had the opportunity of judging will doubt that the mere fact of any carriage requiring man-draught is a fatal objection to it in South China. It is quite possible that a very narrow standing carriage fitted for the mountain howitzer, and supplied with light shafts or lasso harness, might be found *occasionally* useful; but for all practical purposes the general pattern of field carriage sent out with the light batteries in 1857 is quite satisfactory, *if* provided with the usual and proper means of draught; *without* which, however, the PRINCIPAL ARM becomes a serious impediment.

It may be mentioned, *apropos* of the service carriages sent out to Canton, that several of the block trails broke short off near the sponge-shoe during practice. This appeared to be attributable to timber of too short grain, and perhaps to the iron plate of the sponge-shoe interfering with the elasticity of the wood, and can be easily remedied. The material and workmanship of the gun carriages was otherwise excellent.

In the Chinese war of 1842, ordinary coehorn mortars, with trucks fitted

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to the wooden beds were, it is said, used with success; and would probably be found valuable in another Canton campaign, where an insulting but generally invisible enemy is to be met on ground full of elevations, ravines, and natural cover. The coehorn mortar has about the same effective range as the mountain howitzer, is lighter than it, and makes very fair practice; it would probably be found a useful adjunct to a light battery, and being of the same calibre ($4\frac{2}{5}$-in.) the stores might be assimilated to some extent, and little additional trouble imposed, as regards equipment or transport.

R. E. C.

South Taku,
September, 1860.

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Despatch of Captain Mercer, R.A., commanding the Royal Artillery in New Zealand, during operations from 13*th to* 19*th March*, 1861. *Communicated by the* DEPUTY-ADJUTANT-GENERAL, *Royal Artillery.*

No. 7 REDOUBT, HUORANGI,
April 6, 1861.

SIR,

I have the honour to report for your information the operations of the Royal Artillery under my command from the 13th March to the 19th March, 1861. The half-battery of Armstrong guns arrived at the Waitara from Auckland at 9 a.m. on the 13th March; we commenced disembarking in surf boats, and by the same afternoon they were ready for service. The guns were taken out of their cases, cleaned and mounted, the ammunition re-examined, and the whole was found to be complete and in perfect order. The next day, according to Major-General Pratt's directions, I rode with Mr Parris to select a favourable position for shelling Mataitawa, the stronghold of Wirimu Kingi; but the distance of the nearest spot from which it could be seen over the tops of the trees was beyond the range of the 12-pr. Armstrong gun. Whilst away on this duty, Lieutenant Pickard with Serjeant-Major R. Hayes had the men drilled and exercised in laying the guns, so as to be satisfied that they had not forgotten what they had learnt in England. The artificers at the same time were busily employed in making poles, &c. for bullock draught. Three poles were completed during the day, thus enabling the guns to start for the front at 6 a.m. the next morning, Friday, 15th March. When the half-battery arrived at No. 7 Redoubt the white flag was flying on the "Pah," but about the middle of the day it was hauled down, and the red war flag was hoisted instead; this was immediately followed by volleys from the natives. I was speaking with the late Lieutenant Macnaghten, R.A. at the time, in the advance parallel, but returned to No. 7 Redoubt when the Armstrong guns, and 8 and 10-in. mortars were opened on the rifle pits of the enemy's position at distances varying from 820 to 900 yards. The whole position from left to extreme right forms a curve about a mile in extent, and is naturally a strong one, from being situated on the edge of the forest, as well as from the nature of the ground; it consists of the "Te arei" Pah, which is a mass of rifle pits with a dense bush in rear for escape; on the right of the Pah is a precipice overhanging the Waitara river, and on the left of the Pah extends a range of hills commanding the approach to it, having a deep gully and bush in front of them, and the forest in their rear. The slopes of these hills as well as their steep declivities are full of ingeniously constructed rifle pits; many of these pits are concealed by a stunted growth of bush, so that the presence of our all but invisible enemy is often only known by the puffs of smoke from their rifles or guns, or occasionally a few heads appear above the crest of their line of pits for a moment or so, and then as suddenly disappear; they lie concealed for hours, and now and then by single shots, and sometimes by volleys, they endeavour to do all the mischief they can. I have been particular in describing the position and mode of warfare of these natives as it appeared to me at the time, in order the more fully to explain the method I adopted to use the Armstrong gun against them with the best

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effect. After a trial shell on each of their positions, and the range having been accurately obtained, the guns were laid just below the crest of the line of their rifle pits, so that the shells when discharged should penetrate some three feet of earth, and fixed with concussion fuze only, should burst inside their pits, when they retired after delivering their fire. The guns were loaded and laid, and the gunners, with lanyard in hand, waited for the word from the officer, who was watching until some heads appeared above in that direction, or a puff of smoke revealed their presence, when the gun was instantly fired, and the shell entering just below the crest of their pits burst inside. The natives were in the habit of firing volleys in the morning and evening whilst our working parties were going to or returning from the head of the sap; on these occasions the Armstrong guns were laid upon the lines of the pits, the shells fixed with time and concussion fuzes, and before the working parties marched, the gunners were ready waiting for the word, which was given directly the natives opened fire, and the shells almost at the same instant burst amongst them. Lieutenant Pickard made some excellent shell practice from the Armstrong gun, and also Serjeant-Major R. Hayes. The mortar battery was situated on the right, outside No. 7 Redoubt, and in order to harass the enemy as much as possible, firing was carried on during the night at uncertain hours, and the mortars laid on different positions, so that they could never tell when and where the shell was coming. The practice of the mortars was very good, the shells dropping in their pits, both in the Pah, and on the hills to the right, burying and destroying everything near to them. Captain Strover had command of the mortar battery; the mortars were fired at intervals during the whole day whenever there were any signs of the presence of the natives in their pits. On Saturday an attack was made on the extreme right, and a 9-pr. gun accompanied a detachment of the 40th Regiment, and began by firing some rounds of common case into the bush; and subsequently, on the natives retiring to their rifle pits on the edge of the wood to the right, some shrapnel shell were sent amongst them, some time after the firing ceased on the part of the enemy. On Sunday afternoon, I deeply regret to say Lieutenant E. C. Macnaghten, R.A. was killed whilst laying a coehorn mortar in the extremity of the advance parallel, the ball passing through the wrist and entering his chest; he died almost immediately, firing his last shot on the anniversary of his firing the first shot in this war; he had ably conducted the fire of the coehorn mortars since the advance of the sap from No. 8 Redoubt, and had been in every engagement throughout the whole war. We were deprived of his most valuable assistance, and the service has lost in him a most brave, efficient, and able officer; he was beloved by all. Serjeant J. Christie, R.A., a first-rate non-commissioned officer, was wounded in the shoulder in the advance parallel early on Monday morning, whilst I was arranging with him about carrying on the practice.

Some hours after, observing a red war flag hoisted on a hill to the rear of the Pah, some 1900 yards distant, and also perceiving some natives working as if they intended to occupy a new position of rifle pits, when they would be obliged to retreat from the Pah, the guns were laid, and some Armstrong shell, with time and concussion fuzes, were sent amongst them; one of these shells burst at the foot of the flagstaff, when they immediately hauled down their flag, and it was not hoisted again.

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This is the only occasion I fairly got a good sight of the enemy; I could see them in relief against the sky on the crest of the hill; I suppose they imagined they were out of range, but when they found the shell bursting amongst them they disappeared, and I saw them no more in that direction. The firing from the Armstrong guns and mortars commenced at 6 a.m., and continued whenever a favourable opportunity offered until dusk. The following evidence has been given concerning the action of the Armstrong shell with the concussion fuze only:—Color Serjeant J. Morant, Royal Engineers, was at the head of the sap and saw an Armstrong shell go through a rifle pit, about four feet of earth, and burst inside, and heard the enemy shout as in pain; he also observed that the shell from the Armstrong gun entered the rifle pits as soon or sooner than the report was heard, so that the natives had not time to get out of the way;—Bombardier J. Singer, No. 3 Battery, 12th Brigade, Royal Artillery, was at the head of the sap and in the advance parallel with the coehorn mortars, when he saw several shell from the Armstrong gun go through the enemy's rifle pits and burst inside. After the cessation of hostilities, one of the natives told my serjeant-major that they were sometimes able to get out of the way of the mortar or large shells, but never out of the way of the shell (whether with time and concussion, or concussion fuze only) from the gun "all the same as rifle," meaning the Armstrong guns, as the shell was amongst them as soon as they heard the report. These natives have designated the Armstrong shell, "the quick shell." I found it had been the practice (this was suggested by the Royal Engineers, and carried out at their request by the Naval Brigade) of placing every night in the sap roller an 8-inch naval shell, with a friction tube fixed through the fuze, and a cord attached to it, and passing through a hole in the side of the wooden box, the end of the cord was attached to the sap roller, so that if the natives attempted to capture the sap roller, in rolling it the shell would explode. In the event of their trying to take the sap roller, I calculated that in all probability the main rifle pits in front of the Pah about 50 yards from the sap roller would be lined with natives watching the operation, or at hand to give help to secure the roller if they required more assistance. The trap of the shell succeeded, an attempt to capture the roller on Saturday night caused the shell to explode, on hearing which, I left my tent and sent the Armstrong shell amongst them, I also fired the whole of the mortars which had been laid in the Pah, the shell bursting with good effect. The Armstrong guns had been loaded and laid on these pits the last thing before dark every night. Notwithstanding the skilfully constructed underground works of these natives, I feel certain that the Armstrong shell has searched them out and done execution, to what extent of course I cannot tell, the natives themselves alone know; I have no means of actually deciding, for they are very jealous of our knowing any loss they may sustain. The different statements made both by those who were in the sap as well as by the natives themselves, corroborate the observations taken from the battery, viz. that the Armstrong shell with concussion fuze only entered the crest of the enemy's rifle pits and burst inside; whether there were few or many natives in the pit at the time cannot be ascertained. On Monday afternoon an attack was made on our extreme right in the wood; during this attack the Armstrong guns were used against the main rifle pits just in front of the Pah, to keep down the fire of the natives on the head of

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the sap; a 9-pr. gun and a 24-pr. howitzer were taken down towards the wood, the former under Captain Strover, R.A., and the latter under Lieutenant Pickard, R.A.; the practice with common and shrapnel shell was with good effect, after the natives had been driven from the bush to their rifle pits by a few rounds of common case;—these pits formed a continuation of cover from the flagstaff hill to the edge of the wood. Gunner T. Selford was wounded in the leg, he was one of the detachment serving the 9-pr. gun.

At four o'clock on the morning of the 19th March, I left the Redoubt with an escort of the guard and fired the two last mortars at the Pah, and two hours afterwards the white flag was flying from it. There can be no doubt of the superiority of the Armstrong gun over smooth-bored ordnance. The gun has done and always will do a great deal more than any other description of ordnance in this service, throwing the shell with greater precision, &c. There were forty time fuzes, and one hundred and nine concussion fuzes expended; in all 109 Armstrong shell.

(Signed,)

H. MERCER, Captain,
Commanding Royal Artillery.

To Colonel C. Bingham,
Deputy Adjutant-General,
&c. &c. &c.
Royal Artillery.

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[CONFIDENTIAL.]

Report of Ordnance Select Committee, No. 1404, *January* 26, 1861. *Breaching Experiment with smooth-bored guns against Martello Tower No.* 49, *near Bexhill, Sussex. Communicated by direction of the* SECRETARY OF STATE FOR WAR.

Colonel St GEORGE, *President.*
Captain SIR W. WISEMAN, Bt., R.N., *Vice-President.*
Brevet-Colonel ROBINSON, R.E.
Brevet-Colonel GREATHED, C.B., Unatt.
Lieut.-Colonel F. CAMPBELL, R.A.
Brevet-Colonel LEFROY, R.A., *Secretary.*

Brevet-Lieut.-Colonel W. O. LENNOX, R.E., *Executive Royal Engineer.*
Brevet-Lieut.-Colonel J. E. MITCHELL, *Royal Artillery, commanding the Battery.*

The following detachment was detailed for this duty by Colonel Cuppage, R.A., commanding the district:—

5 officers and 1 assist.-surgeon, 3 serjeants, 68 rank and file, 17 drivers, 3 artificers, 4 trumpeters, 27 horses.

1. The object of the experiment on which the Committee have now the honor to submit a report, was to obtain a direct comparison of the efficiency of smooth-bored and rifled ordnance of nearly corresponding calibres, for breaching purposes, by repeating with the former the operation conducted with Armstrong guns at Eastbourne, in the month of August last; Report, No. 1083, September 8, 1860.

2. The tower delivered over to the Committee for this purpose, is No. 49, on the coast of Sussex, near Bexhill; its removal having become necessary by the encroachment of the sea, which has caused the edge of the cliff on which the tower is situated to recede within five feet of the base of the tower. The description of No. 71, given in the report above referred to, applies exactly to No. 49, which was constructed on the same plan. It was built about the year 1804, at a cost of about £3000. of brick, to accommodate 20 men, with magazine space for 80 barrels of powder, and mounting one gun on centre pivot traversing platform. The principal dimensions are as follows:—

	ft.	in.
Diameter at the top	40	0
Diameter at the foot	46	0
Height	32	6
Height inside to the springing of the vault	18	6
Least thickness at the foot	7	8
Least thickness at the springing on the vault	5	6
Thickness at the base on the central line of fire	7	10½
Thickness at the springing of the vault	6	7½
Thickness of masonry over the crown of the vault	5	0
Diameter of internal central column supporting the vault	4	6

3. The battery was established at the same distance from the tower as on the last occasion, viz. at 1032 yds., and in nearly the same relative position in respect to the thickness of the part immediately opposite, but a somewhat thicker part of the wall came under fire towards the right on this occasion

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than on the former one. The situation was on a rising ground, about 35 ft. higher than the base of the tower. The battery consisted of—

Two 68-pr. guns of 95-cwt., charge 16 lbs., shell, 40¼ lbs., burster, 2¼ lbs.
Two 32-pr. guns of 58-cwt., charge 10 lbs., shell, 22½ lbs., burster, 1 lb.

The whole were on garrison rear chock carriages, on ground platforms 15 feet long, and laid with a slope of $\frac{1}{24}$th (2½ degrees). One carriage of each nature was provided with a species of break to each truck, which had the effect of reducing the recoil about one-fourth.

4. The fire was opened on the 10th November, and the programme laid down corresponded exactly with the former programme, as to the number of shots or shells to be recorded, and the stages at which photographs should be taken. 100 rounds of shot, and 200 rounds of naval shells, were provided per gun; making a total of 1200 rounds.

5. Disregarding at present rounds which missed the tower entirely, which amounted to a large proportion of the whole, the following is an abstract of the first section of the day's proceedings.

TABLE I.—Effect of solid shot and blind shells. The angle of incidence of the shot has in each case been found nearly, by projecting the line of fire on a large scale, and is the angle between the line of fire and a tangent to the tower at the point struck.

68-pr.		32-pr.		
No. 1.	No. 2.	No. 1.	No. 2.	
	2	...	...	Struck on 110 course on the extreme right flank of tower, and glanced off, causing a superficial displacement of 4 ft. by 2 ft. 2 ins. Angle of incidence about 32°.
3	...	...	...	Struck on 10 course on the extreme right flank of tower, and glanced off; angle about 92°.
		4	...	Struck the ground about 21 yds. short, and on rising struck the tower centrally about course 4, and penetrated 17 ins.; angle 82°.
			5	Struck extreme right flank on course 34, and glanced off; angle about 22°.
6	...	...	...	Struck ground 34 yds. short, and on rising struck the tower centrally on course 30, penetrating 15 ins. to base of shot, and disturbed 10 courses; angle 87°.
	7	...	...	Struck ground 25 yds. short, and ricocheted on tower at course 15; angle 70°; penetrated 18 ins., and caused a superficial displacement of over an area of 4 ft. by 3 ft.
8	...	...	...	Struck on course 45 on the new brickwork, which closed the doorway. Shot penetrated about 16 ins., and rebounded 10 paces at an angle of about 80° with the line of fire, causing a displacement of masonry 4 ft. by 2 ft. 9 ins.; angle of incidence about 50°.
		9	...	Ricocheted 89 yds. short, and struck tower on 83 course; penetrated to base of shot about 12 ins., displacing 7 courses; angle about 85°.
			10	Struck ground 31 yds. short, and on rising struck tower on course 23; penetration 20 ins. to bottom of crater; displacement of masonry 23 ins. by 23 ins.; angle about 85°.
	16	...	...	Blind shell. Struck on course 98; penetration to base of shell 16 ins.; superficial displacement 3 ft. by 2 ft. 10 ins.; angle about 76°.
17	...	...	...	Blind shell. Struck on course 46 on new brickwork close to No. 8; shell broke to pieces on striking; area of displacement, 3 ft. 6 ins. by 4 ft. 4 ins.; angle about 50°.
	18	...	...	Struck centrally on course 100; penetration 27 ins. to base of shell; area of displacement, 28 ins. by 28 ins.; angle 76°.

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6. The tower was examined at this stage. The effect externally was as described in Table I. In the interior no displacement of brick or crack of any kind was perceptible.

After taking Photograph 2, the firing was resumed with live shells, using Moorsom's percussion fuzes, which were shortly afterwards changed for a new description of percussion fuze, proposed by Mr Pettman, Royal Laboratory, in consequence of a large number of premature bursts. The Committee will return to this subject below. Practice was continued with live shells until the total number of 18 hits had been made, corresponding to the stage at which the third photograph was taken on the last occasion.

7. The following is the detail of this part of the practice, omitting rounds in which the shell burst near the muzzle of the gun, and misses.

TABLE II.—M.P., Moorsom's Percussion Fuze; P.P., Pettman's Percussion Fuze.

68-pr.		32-pr.		
No. 1.	No. 2.	No. 1.	No. 2.	
	19	...	...	M.P. Struck on course 100: angle, 78°; exploded. Penetration 33 ins.; displacement 32 by 48 ins.
22	...	...	...	M.P. Struck on course 110; angle 56°; exploded. Penetration 24 ins.; displacement 60 by 37 ins.
			28	M.P. Fell short and struck the tower on ricochet in the crater made by 16, 18, and 19, course 100; angle 78°; penetration 33 ins.
		29	...	M.P. Struck centrally course 16, a little to the right of the centre line; angle 84°; penetration 13 ins.; displacement 42 by 45 ins.
36		...	...	P.P. Struck course 32 in the same place as No. 5, at an angle of 25°; penetration 14 ins.; displacement 47 by 33 ins.
	39	...	...	P.P. Struck on course 70, at angle of 88°; penetration 24 ins.; displacement 33 by 39 ins.

8. The above ended the first day's practice, and Photograph 3, intermediate between No. 2 and No. 3 of the other series, was taken before proceeding further. The tower was but superficially injured, the places struck being much scattered; 9 shots had struck on the two centre divisions, between the 10th and the 110th course, and one below the 10th; but the quantity of material brought down will be seen to be trifling. The effect visible inside was confined to a fine crack behind the centre line, extending 4 ft. downwards from the spring of the arch.

9. Firing was resumed on Monday, Nov. 12, in presence of H.R.H. the Commander-in-Chief, and continued until the tower had been struck altogether 36 times. The weather was fine, with a light westerly wind across the line of fire. Without following every round in detail; the following are quoted as hits in places untouched before, and available for penetration.

TABLE III.

68-pr.		32-pr.		
No. 1.	No. 2.	No. 1.	No. 2.	
		42	...	M.P. Struck course 10, at an angle of 82°; burst; penetration 18 ins.; superficial displacement 36 ins. wide by 30 ins. high.
			43	M.P. Struck on course 30, angle 66°; burst; penetration 10 ins.; displacement 22 ins. by 24 ins.
			51	P.P. Struck course 31, angle 65°; burst; penetration 15 ins; displacement 30 by 32 ins.
57	...	...	...	P.P. Struck in the hole formed by No. 6, which had lodged there, and bursting blew out that shot to a distance of 23 yards; joint penetration 39 ins; superficial displacement over 60 by 64 ins.
66	...	...	...	P.P. Struck on course 81, an angle of 70°; penetration 15 ins.; displacement 36 by 21 ins. This shell did not burst.

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10. Photograph No. 4, corresponding with No. 3 of the former series, was now taken. The tower presented a considerable crater above the spring of the vault, between the 82nd and 110th course, where 8 shots had taken effect within a space of about 8 by 7 feet, caving the brickwork to a depth of 39 inches; another crater appeared at the foot of the centre line *C*, where 6 shots had taken effect within a space of 9 by 4 feet, the other marks were scattered; but 3 occurred within a circle of 5 feet diameter, which included the new brickwork, closing the doorway; none of these had penetrated to the interior.

11. The wall was cracked inside, and some of the courses of bricks slightly started, but the damage was unimportant, the greatest number of shots had struck above the spring of the vault. At the corresponding stage of the practice with the Armstrong guns, owing to the better concentration of their fire, a large opening appeared in the tower.

12. Several photographs were taken in the course of the succeeding practice on the 12th, 13th, and 14th instant, by which a better idea will be obtained of the course of the demolition, than can be given by verbal description; the following points however, may be specified. The part of the tower that seemed to receive the most shots, was a crater formed a little to the right of the centre, between the top of the parapet and the spring of the vault. The 47th hit (a 68-pr. shell) penetrated the foot of the parapet here, making a hole about 16 inches across. At the same time, a crack was traceable inside, from the middle of the vault to the basement. Hits 50, 51, 52, 53, were in salvo, but produced no marked effect; two more salvoes were then fired, three shots out of four in each striking the tower. On examining the interior, three courses of bricks in the basement were found to be started inwards, about one and a-half inch at the level of course 28; numerous fine cracks extended upwards and downwards from this place.

Four more salvoes were then fired, ending the practice of the 2nd day, November 12. The number of projectiles that had taken effect was as follows:—

Nature of Gun.	Solid Shot.	Blind Shells.	Live Shells.	Total.
68-pr.	17	3	24	44
32-pr.	8	0	17	25
Total	25	3	41	69

Rounds fired, 120, included 18 shells which burst prematurely.

The exterior effect is represented in Photograph No. 4. The principal crater in target No. 3 was now 5 feet 3 inches deep. One coping-stone on the top of the tower had been displaced, and two or three others injured; the granite curb-stones forming the banquette were shaken over a length of 16 feet, and the cracks behind the central line, in the interior, had extended themselves, but were still nothing more than fine cracks.

13. Tuesday, November 13th, was an unfavourable day for the practice; the wind high and variable, across the range. Practice was resumed with

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blind shells, with a view to obtain some additional data as to their penetration; they were filled as usual with powder, but without fuzes; but no favourable hits occurred in 16 rounds of each nature. Of these, ten 68-pr. shells took effect, two of which broke and exploded on striking the tower, and nine 32-pr. shells. Some Moorsom's fuzes of early date (1851-2) were then tried with 68-pr. shells, to ascertain whether they were less liable to cause premature explosion than those of recent manufacture. The result, however, shewed little difference in this respect; 3 shells out of 9 burst at or near the muzzle of the gun. Subsequently, Boxer's naval time-fuzes, bored to 5 seconds, were employed with very satisfactory results. Photograph No. 7 was taken immediately after a first salvo of 4 shells with these fuzes, of which 3 took effect, and occasioned the fall of about 11 feet of the parapet (measured on the exterior).

14. The following projectiles had now taken effect:—

Nature of Gun.	Solid Shot.	Blind Shells.	Live Shells.	Total.
68-pr.	24	13	29	66
32-pr.	24	9	18	51
Total	48	22	47	117

Rounds fired, 192. The effects were as follows:—

The gap in the parapet was 4 feet 5 inches across inside, and 10 feet outside. The adjacent coping-stones were loosened for a distance of 10½ feet to the west (left), and 8 feet to the east (right). The banquette was separated about 1½ inch from the granite curb. In the basement story, the masonry of 8 courses was bulged inwards between the lines *A* and *B*, and again over 10 courses between *C* and *D*, both being points which had received numerous blows; a similar effect appeared in the upper floor above these points, where also many shots had struck; various fine cracks appeared in the wall, and one ran for several feet through the vaulting. The exterior of the tower was irregularly pitted with craters of various depths up to 3 feet, but the quantity of brickwork lying at the foot was still insignificant, nowhere rising above the level of course 10.

15. The remainder of this day's practice was carried on with live shells, having 5-second time-fuzes, of which 17 more took effect; viz. nine 68-pr. and eight 32-pr. shells, making 20 altogether. The expenditure of ammunition then amounted to 228 rounds, and the hits were as follows:—

Nature of Gun.	Solid Shot.	Blind Shells.	Live Shells.	Total.
68-pr.	24	13	38	75
32-pr.	24	9	26	59
Total	48	22	64	134

Photograph No. 8 represents the exterior of the tower at this stage. It will be seen that 8 ft. more of the parapet is reduced to half its thickness by a fall of the exterior, and the superficial destruction about the centre is percep-

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tibly increased; but that the only breach is the gap in the parapet produced by rounds 186—192, fired in salvo; neither shot or shell had made its way into the interior.

16. The practice of the fourth and last day (November 14th) was principally intended to bring up the number of hits to the same total as on the former occasion. The platforms were now much the worse for wear; heavy rain in the night had saturated the ground, making them uneven and springy. Having been originally too short (15 feet), and laid at only $2\frac{1}{2}°$ slope, now that they were thoroughly slippery, the guns, unprovided with breaks, recoiled off them at almost every discharge, occasioning excessive labour to the men, notwithstanding the use of tackle manned by double detachments to run them up. The practice, however, did not appear much affected; indeed, it was rather better than on the previous day, when they were not in quite so bad a state; only one miss occurred in the last seventeen 68-pr. shots. Photograph 9 represents the state of the tower at the conclusion. Expenditure of ammunition, 271 rounds; of which took effect as follows:—

Nature of Gun.	Round Shot.	Blind Shells.	Live Shells.	Total.
68-pr.	40	11	44	95
32-pr.	24	9	35	68
Total	64	20	79	163

corresponding generally to the undermentioned detail of Armstrong prejectiles which took effect against tower 71:—

Nature of Gun.	Solid Shot.	Blind Shells.	Live Shells.	Total.
80-pr. gun	19	8	36	63
7-in. howitzer	0	2	29	31
40-pr. gun	20	1	43	64
Total	39	11	108	158

The great inaccuracy of the fire with shells led, after a time, to the substitution of round-shot for a portion of the practice. Two very slight grazes on the extreme right, at courses 40 and 70, which are wholly unconnected with the general effect, and five grazes on the extreme left, which are also scarcely visible in the front view, and unconnected with the bruise near the doorway, on line *A*, make up the seven hits by which the number on tower 49 exceeds that on tower No. 71.

17. On examination of the interior, it was found that one 68-pr. shot had penetrated to the upper room by a hole in the vaulting, at the top of line *C*, and two others had penetrated by as many holes immediately above the floor line, but had fallen into the basement, and there was one hole into the basement itself also formed by a 68-pr. shot, four altogether being found inside; seen from within, the holes were not much larger than the shot, and the quantity of broken brickwork was inconsiderable. The surface of the tower was generally demolished, but unequally. The superficial area of one

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face, or semi-circle of the tower, is about 2020 square feet; effect was visible over 1072 square feet of this surface, and the depth of masonry penetrated having been very carefully measured over the whole surface by Lieutenant-Colonel Lennox, R.E., the following is the result:—

Masonry displaced to a depth of—

Less than	1 foot,	on 240 square feet.
Between	1 foot and 2 feet,	on 367 „
„	2 feet and 3 feet,	on 220 „
„	3 feet and 4 feet,	on 112 „
„	4 feet and 5 feet,	on 33 „
Over	5 feet,	on 56 „
		1028

The average depth of the broken surface was found to be 1·91 feet, and the cubic quantity of masonry removed 2168·8 feet. This result of measurement was confirmed by stacking the débris, when it measured 2471 cubic feet; a difference not greater than would be expected between masonry in a compact state, and the same material rebuilt loose.

18. Taking no account, at present, of the shells which burst near the muzzle of the gun, the above effect was produced by the expenditure of 9684 lbs. of iron in shot and shells, and 3720 lbs. of gunpowder, of which 245 lbs. in bursters; or, counting only those rounds in which the tower was struck, by 7192 lbs. of iron, and 2500 lbs. of gunpowder, of which 134 lbs. in bursters.

19. The expenditure with the Armstrong guns up to the forty-first round, when the entire side from course 60 (answering to 54 on this tower) had fallen away, making an open breach of 20 feet wide, was 2593 lbs. of iron, and 511 lbs. of powder. Before, however, a strict comparison can be made, it is necessary to take account of the comparative breaching-power of the several projectiles, as measured by the *product of their weight into the square of the velocity of the shot or shell at the moment of impact.* This velocity may be assumed, for the present purpose, to be the same as the mean velocity of the same projectile for a range of $2 \times 1032 = 2064$ yards, because such mean velocity represents very nearly the actual velocity of the projectile at the middle point of its trajectory, and will be sensibly the same for the same projectile in striking any object at that distance, although in a slightly different trajectory. As the initial velocity of the larger Armstrong projectiles has not yet been ascertained, and there are neither practical nor theoretical data for calculating the remaining velocity at given ranges, this mode of proceeding is the only one open.

20. The following are data given by observation of times of flight:—

Nature of Gun.	Charge.	Range observed.	At elevation.	Observed time of flight.	Mean velocity due to time.	Nature and weight of projectiles.
	lbs.	yds.	° ′	sec.	ft.	
Armstrong's 7-in. how.	9	2099	7 12	7·80	807	...
„ 80-pr. gun	10	2153	5 17	7·00	923	...
„ 40-pr. gun	5	2100	5 5	6·85	920	...
Service 68-pr. gun	16	2112	5 37	7·50	812	shot, 68 lbs.
„ „ „	16	2008	5 46	7·75	835	shells, 51½ lbs.
„ 32-pr. gun	10	2184	5 10	8·17	784	shot, 32 lbs.
„ „ „	10	1982	6 20	7.83	743	shells, 23½ lbs.

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Taking the effect of the 68-pr. solid shot as unity, the foregoing data gave the following as the order and relative value of the several projectiles under comparison, which we will call *W*:—

	Relative value. *W*.	Bursting charge of shell.
		lbs. oz.
80-pr. solid shot	1·52	5 8
100-pr. shell	1·42	8 0
68-pr. solid shot	1·00	...
40-pr. solid shot	0·76	2 8
68-pr. naval shell	0·78	2 4
32-pr. solid shot	0·43	...
32-pr. naval shell	0·28	1 0

21. These numbers, multiplied by the number of projectiles of each nature fired, will represent approximately the *work done* upon each tower, and are as follows:

Tower 71, Armstrong Guns.			Tower 40, Smooth-bored Guns.		
Nature of projectile.	Took effect N.	Work N. by W.	Nature of Projectile.	Took effect N.	Work N. by W.
80-pr. shot	19	28·88	68-pr. shot	40	40·00
„ shells	44	66·88	„ shells	57	44·46
7-in. howitzer shells	31	44·02	32-pr. shot	24	10·32
40-pr. shot	20	15·29	„ shells	44	12·32
„ shells	44	33·44			
	158	188·51		165	107·10

By which it appears that, irrespectively of the superior concentration of the fire of the rifled guns, and its consequently greater effect, they actually performed half as much work again as the smooth-bored guns, with the diminished expenditure of iron and gunpowder noticed in a previous paragraph.

Penetration.

22. The penetration of all shots striking favourably in undisturbed places was noted, as well as that of many shots which entered places previously broken; the circular form of the tower renders it necessary, however, to confine the observation of direct penetration to shots striking within a few feet of the centre; shots which struck outside the flanking lines *A* and *E* invariably glanced, as did some of those that struck on or very near them. In other words, shots which struck at angles of less than 50° with the surface, generally glanced; and, at less than 40°, did so in all cases. The angles corresponding to the two lines nearest the centre line, as measured from the centre of the battery was about 68°, and to the outside lines about 48°. The following table contains the actual penetrations recorded, and the approximate angle of impact:—

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Projectile.	Round.	Angle of impact nearly.	Penetration.	Displacement.			Remarks.
				Lateral.	Vertical.	Contents. Cubic inches.*	
	No.	deg.	in.	in.	in.		
	6	87	23	21	30	5796	
	73	85	13	27	28	3931	
	7	70	18	42	35	10584	Struck 25 yds. short, and ricocheted.
	80	53	21	31	36	9374	
68-pr. solid shot.	Average...		18·7	30	32	7421	
	2	32	13	48	26	6489	Glanced off.
	3	32	15	48	30	8640	do.
	8	48	16	46	31	9126	
	36	22	14	...	...	...	In nearly the same place as 32-pr. shell, No. 5.
	39	88	24	33	39	6115	
	18	85	35	28	28	10567†	
	16	76	24	24	32	10445†	
	...	...	20	...	...	...	Round—doubtful.
	66	68	15	36	21	4536	
68-pr. shells.	52	60	19	48	42	15322	
	22	56	24	60	37	21312	
	Average...		23	38	33	11383	
	17†	48	15	...	...	...	This shell broke up. It struck upon nearly same place as 32-pr. shot No. 5.
	36	22	14	47	33	8686	
	9	85	12	18	21	1814	Struck 89 yds. short; ricocheted.
	10	85	20	23	23	4232	Struck 31 yds. short; do.
	160	85	14	20	23	2576	
	4	82	17	21	19	2713	Struck 21 yds. short and ricocheted. The shot fell out of the hole.
32-pr. solid shot.	...	...	18	...	...	...	Round—doubtful.
	156	58	14	...	...	...	Struck in the new brickwork which blocked up the window.
Means	...	...	15·8	20	21	2834	
	5	22	11	34	21	3142	Glanced off. No. 36 68-pr. struck nearly on the same place. Penetration, 14 ins.
	29	84	15	42	45	11340	
	42	82	18	36	80	7776	
	43	66	10	22	24	2112	
32-pr. shells	224†	60	21	36	...	...	
	51	60	15	30	32	5760	
	83	48	19	27	36	7387	
Means	...	...	16·3	32	33	6875	

23. It will be seen that the greatest effect was not always produced by the shots which struck most direct, and that with both guns we have greater average penetration with shells than with shot, tending to shew that the explosion of the shell deepens the hole in brickwork a little, and also brings down a considerably larger quantity of material, but the number of observations is scarcely sufficient to base a general conclusion upon.

* From the measurement of Lieutenant-Colonel Lennox, R.E. The quantity taken is *four-tenths* of the penetration multiplied by the mean height and width of the external displacement.

† Blind shells.

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The penetration should be directly as the *vis viva* of the shot, and inversely as area of the section; or, as the diameter into the square of the velocity. Taking that of the 32-pr. shot as 15·8 ins., that of the 68-pr. shot should be about 20·4 ins.; the actual mean penetration is 18·7, but if we omit the 73rd round, it is 20·6, which is very nearly in that proportion. The difference in favour of the 68-pr. against the 32-pr. shell is in a higher ratio, due doubtless to its holding 1 lb. 4 oz. more bursting-powder.

In comparing the above results with the penetrations of the projectiles from rifled guns, we find,

6-inch Armstrong Gun.

Round 7. 6-inch solid shot weighing 82 lbs., charge 10-lbs., penetrated the doorway of No. 71 tower, where the brickwork was 7 ft. 6 ins. thick. The brickwork was laid in Roman cement, but was new, and not bonded to the rest of the wall, as if originally built with it. The penetration occurred at the junction of two surfaces, and can, therefore, scarcely be taken as equivalent to penetrating 7 ft. 5 ins. of solid brickwork.

Round 10. 6-inch solid shot struck above the springing of the vault on course 92, equivalent to 98, tower 49, and passed through 7 ft. 6 ins. of masonry in a downwards direction, striking the pillar within.

Round 12. 6-inch blind shell, made up to weigh 77 lbs., charge 9 lbs.; penetrated 4 ft. 3 ins.

7-inch Howitzer, Armstrong.

Round 5. 7-inch blind shell, weighing 100 lbs., charge 9-lbs.; penetrated 4 ft. 3 ins.

Round 9. 7-inch blind shell penetrated 3 ft. 2 ins.

40-pr. Armstrong Gun.

Round 1. 40-pr. solid shot, charge 5 lbs.; penetrated 4 ft.

Round 11. 40-pr. blind shell, weighing 41 lbs.; penetrated 4 ft. 3 ins.

24. The mean of the foregoing observations, furnishes the following approximate table of the comparative penetrations of Armstrong and spherical projectiles, respectively, into brickwork of the best quality, at 1032 yards:—

Armstrong.				Smooth-bored Guns.				
Nature of projectile.	Weight.	Charge.	Penetration.	Nature of projectile.	Weight.	Charge.	Penetration.	Remarks.
	lbs.	lbs.	ft. in.		lbs.	lbs.	ft. in.	
7-in. shell ...	100	9	3 8	68-pr. shot	68	16	1 8	Rejecting round 73.
6-in. shot ...	82	10	7 6	„ shell	51	16	1 9	
„ shell ...	77	9	4 3	32-pr. shot	32	10	1 4	
40-pr. shot } „ shell }	41	5	4 1	„ shell	23½	10	1 4	

The Metz experiments of 1834, gave for 1000 metres (1094 yards) a mean penetration of 18·2 ins. into good rubble masonry, to be increased *three-fourths* for brickwork. This would give 1 foot 9·2 in. for brickwork,

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with a projectile of 36 lbs., charge 12 lbs. The increased penetration of the rifled projectiles is in a far higher ratio than theory would assign to them. It is plain, therefore, that we must look for some other cause than their superior *vis viva*, and this is furnished by their rotation on their longer axis. The 6-inch projectiles leave the muzzle of the gun spinning at the rate of about 63 turns per second. It is not probable that this rate diminishes as fast as the motion of translation. It will be very little reduced in 3 or 4 seconds, or at 1032 yards, and must materially aid penetration.

25. Several circumstances presented themselves in the course of the foregoing experiments, which call for remark in detail. These the Committee will now proceed to consider.

Fuzes.—Moorsom's Percussion.

26. Twenty-one 68-pr. and seven 32-pr. shells in all, were fired with Moorsom's percussion fuzes; of these, 9 burst at the muzzle of the gun, affording a clear proof that these fuzes will not stand the full service charges ordered (Circulars 590 and 639) to be used with all shells. The same thing has happened with 11 out of 72 shells fired at Portsmouth or Shoeburyness in experiments ordered since the promulgation of the order in question. It was at first imagined, that there might be some difference between the fuzes of recent manufacture, and those of earlier date, and accordingly some of the oldest that could be found were selected. They bore dates 1851 and 1852. Of the 32-pr. shells, 10 lbs. charges, fired with recent fuzes, the premature bursts were 4 in 7. Of the 68-pr. shells, 16 lbs. charges, fired with recent fuzes, the premature bursts were 6 to 12; and of those fired with fuzes of 1851-2 were 3 to 9, a difference sufficiently in favour of the old fuzes, to merit investigation, but not enough to exempt them from the above remark. It was considered a waste of ammunition to fire more of them on the present occasion, and not unattended with danger to the bystanders; they were therefore withdrawn. All the shells with Moorsom's fuzes which struck the tower burst, namely, five 68-prs., and four 32-prs., three 68-pr. shells which missed the tower burst on striking the sea beyond; 3 struck the water, and were observed not to burst; 1 uncertain.

Fuzes.—Pettman's Percussion.

27. The Committee, after the failure of the Moorsom's fuzes, proceeded with a new percussion fuze proposed by Mr Pettman, Royal Laboratory, and still under experimental trial. Of these, 73 were fired, namely, 44 in 68-pr. shells; 29 in 32-pr. shells; with the following results:—

	68-pr.	32-pr.	Total.
Burst prematurely	3	1	4
Burst on striking the tower	23	20	43
Missed the tower, but burst on striking the sea	9	6	15
Missed the tower, and did not burst on striking the sea	4	0	4
Struck the tower, and did not burst	1	0	1
Not observed	4	2	6
	44	29	73

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Only 5 therefore of these 73 fuzes were imperfect, viz. the 4 which burst prematurely, and the one which did not burst on striking the tower. They shewed an advantage over the Moorsom fuzes in resisting the shock on water.

Fuzes.—Naval Time.

28. The remainder of the shells were fired with naval time fuzes, adjusted to 5 seconds, so as to allow an interval of about 2 seconds after striking, before explosion, with the following results:—

	68-pr.	32-pr.	Total.
Struck the tower and exploded	16	18	34
Missed the tower, but exploded in flight, in several instances after striking the water	8	11	19
Did not burst	2	5	7
	26	34	60

The best effect was thought to be produced by the shells which lodged before explosion, but their advantage over the percussion shells was not very decided.

Three 68-pr. shells fired blind, broke upon striking the tower, out of 10 which struck. This did not occur with any of nine 32-pr. blind shells which struck.

Platforms. Recoil.

29. As stated, paragraph 16, the platforms were too short, and might have been laid with advantage at a greater slope than 2½°. The average recoils were as follows:—

Platform Dry.	68-pr.	32-pr.
	ft. in.	ft. in.
Firing shot without break	9 0	6 6
„ with break	6 2	3 0
Firing shells without break	7 1	4 7
„ with break	6 6	2 7
Platform Wet and Slippery.		
Firing shells without break	9 7	Not recorded.
„ with break	8 1	

The 32-pr. gun and rear-chock carriages together weigh 69½ cwt.; the 68-pr. gun and rear-chock carriage weigh 110½ cwt.; the carriage of the latter is relatively lighter than that of the former, which partly accounts for the greater recoil, with a less proportionate weight of powder. It has not been usual to mount so heavy a gun as the 68-pr. of 95 cwt. upon a ground platform; and the Committee are persuaded, from what they saw on this occasion, that it cannot be done with advantage. The labour of running up the guns was excessive, even with side-tackle and strong gun detachments. The use of the break or truck-compressor reduced the recoil, as will be seen, about 2 ft. 9 ins. It was found that the application of a small quoin behind each truck reduced the recoil a foot or two.

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Accuracy of Fire.

30. The elevation allowed was from $1\frac{3}{4}°$ to $1\frac{7}{8}°$ for the 68-prs.; and $1\frac{1}{2}°$ to $1\frac{7}{8}°$ for the 32-prs.; the guns were generally laid at the horizontal line and the centre of the tower, but occasionally an allowance was made for the wind. The practice was indifferent, as may be inferred from a large number of the shot and shells missing the tower altogether, although it presented a mark of about 1420 square feet, and subtended, in the horizontal direction, an angle of nearly 50′; in the vertical direction, an angle of nearly 40′.

The hits and misses were as follows:—

	Hit.	Miss.	Proportion of misses.
68-pr. shot	40	4	9 per cent.
32-pr. shot	24	2	7 „
68-pr. shells	57	25	30 „
32-pr. shells	44	34	43 „

Shewing the very great advantage of shot over shells, in point of accuracy, for distant fire.

Magazine.

31. The magazine provided on the ground consisted simply of a laboratory tent for the shells, and a French tent for the powder, which was all in metal-lined cases; the two tents were connected by a passage. The arrangement succeeded perfectly well.

Unexploded Shells.

32. A fatal accident having occurred at Eastbourne, subsequent to the experiment against tower 71, by a soldier of the 19th regiment rashly applying a match to an unexploded shell which he found among the rubbish, the Committee took pains to have the fuze or plug extracted at once from every unexploded shell, and the charge drowned. There was no difficulty in doing this on the present occasion, the quantity of rubbish not being sufficient to bury the shells. It was done by experienced persons, sent for the purpose from the Royal Laboratory, with proper instruments.

(Signed) J. ST GEORGE,
Colonel Royal Artillery,
President.

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The following is a full detail of all the shots fired against tower 49.

The letters A, B, C, D, E, refer to the vertical lines, read from apparent left to right, or from east to west.

M—Moorsom's percussion fuze.
P—Pettman's percussion fuze.
T—Naval 7½-seconds time fuze.

Date.	Gun. 68-pr.	Gun. 32-pr.	Projectile.	Fuze.	Effect.
1860.	Rounds.				
Nov. 10	1	...	Shot	...	Short, and missed to right.
	2	...	"	...	Struck high, course 110, right of line E.
	3	...	"	...	Struck low, course 10, right of line E.
	...	4	"	...	Struck at the foot of C, course 4.
	..	5	"	...	Struck on 32, right of E.
	6	...	"	...	Struck right of C, on 30, and remains in the masonry.
	7	...	"	...	Struck ground 25 yds, ricocheted and struck foot of A on course 15.
	8	...	"	...	Struck course 45 on A.
	...	9	"	...	Struck the ground 89 yds. short, ricocheted and struck course 83 between C and D.
	...	10	"	...	Struck 31 yds. short, ricocheted and struck to left of C on 23.
	11	...	Plugged shell	...	Miss to left.
	12	...	"	...	Miss to right.
	13	...	"	...	Miss to right, low.
	14	...	"	...	Miss to right, high.
	15	...	"	...	Miss to left.
	16	...	"	...	Struck to left of D on 98, struck in hole; penetration 24 ins.
	17	...	"	...	Struck A on course 46, close to No. 8, broke up; penetration, 15 ins.
	18	...	"	...	Struck on course 100, right of C; penetration, 35 ins. (Photograph No. 2 taken).
	19	...	Shell	M	Struck between C and D near course 100, between Nos. 16 and 18.
	20	...	"	M	Miss to right, no burst.
	21	...	"	M	Miss over, no burst.
	22	...	"	M	Struck course 110 to left of E; penetration, 24 ins.
	23	...	"	M	Burst at muzzle.
	24	...	"	M	Burst at muzzle.
	...	25	"	M	Short to left, did not burst.
	...	26	"	M	Burst at muzzle, cut up turf at 40 yds. in front of the gun.
	...	27	"	M	Burst at muzzle.
	...	28	"	M	Struck very low (qu. on brickwork), then rose and struck course 100; penetration, 33 ins.
	...	29	"	M	Struck low, right of C, on course 16; penetration, 15 ins.
	30	...	"	M	Miss, burst on sand.
	31	...	"	M	Burst at muzzle.
	32	...	"	M	Burst at muzzle.
	33	...	"	M	Miss, burst at sea.
	34	...	"	M	Burst at muzzle.
	35	...	"	M	Burst at muzzle.
	36	...	"	P	Struck low to left of E, on course 32, near No. 5; penetration, 16 ins.
	37	...	"	P	Miss to left, burst on sand.
	38	...	"	P	do burst at sea.
	39	...	"	P	Struck course 70 to right of A, fair hit. (Photograph No. 3 taken).
Nov. 12	40	...	"	P	Miss.
	41	...	"	P	Miss, burst at sea.
	...	42	"	P	Struck on course 10 between C and D; penetration, 18 ins.

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Date.	Gun. 68-pr.	Gun. 32-pr.	Projectile.	Fuze.	Effect.
1860.	Rounds.				
Nov. 12.	...	43	Shell	P	Struck on course 30 to left of B; penetration, 10 in.
	44	...	"	P	Struck on course 99 between C and D; penetration 40 ins.
	45	...	"	P	Miss, but burst on graze.
	...	46	"	M	Burst at muzzle.
	...	47	"	M	Burst at muzzle.
	48	...	"	P	Struck C on course 50, in old hole, burst.
	49	...	"	P	Miss, burst at sea.
	...	50	"	P	15 yds. short, miss, burst.
	...	51	"	P	Struck course 31 between A and B, burst; penetration, 15 ins.
	52	...	"	P	Struck course 40 between D and E, burst; penetration, 19 ins.
	53	...	"	P	Struck course 88 between A and B, old crater; penetration, 33 ins.
	54	...	"	P	Grazed extreme left on course 39, burst; a piece was thrown 500 yds. E.
	55	...	"	P	Struck A on course 20.
	...	56	"	P	Miss, burst at sea.
	57	...	"	P	Struck course 28 between B and C, on hole of No. 6, burst and blew out a 68-pr. shot 23 yds.; penetration, 39 ins.
	...	58	"	P	Miss.
	...	59	"	P	Struck course 14 between C and D, where a large crater already exists.
	60	...	"	P	Burst at muzzle.
	61	...	"	P	Hit C on course 70.
	...	62	"	P	Hit low to right.
	63	...	"	P	Hit to right of E on course 90 and glanced.
	64	...	"	T	Miss.
	...	65	"	P	Burst at muzzle.
	66	...	"	T	Hit D on course 81, no burst; penetration, 15 ins.
	67	...	"	T	Miss.
	...	68	"	P	Miss.
	69	...	"	P	All hit, two in old crater about course 100, one hit coping and knocked over chimney.
	70	...	"	P	
	...	71	"	P	
					(Photograph No. 4 taken).
	72		Shot	...	Struck in large crater about course 90.
	73		"	...	Struck low about C.
	...	74	Shell	T	Struck A about course 40.
	...	75	"	T	Struck course 10, between C and D.
	76	...	Shot	...	Struck to left of old hole on C, about course 90.
	77	...	"	...	Struck course 15 right of E.
	...	78	Shell	P	Burst at muzzle.
	...	79	"	P	Struck on course 35, near C.
	80	...	Shot	...	Struck low near E, about course 30.
	81	...	"	...	Near same place.
	...	82	Shell	P	Graze to left, near course 40, and burst.
	...	83	"	P	Struck course 37, near B.
	84	...	Shot	...	Struck course 92, near D.
	85	...	"	...	Struck near zero, and near E.
	86	...	Shell	P	Burst on C, course 90.
	87	...	"	P	Miss to right, burst.
	...	88	"	P	Miss to right, burst.
	...	89	"	P	Burst at muzzle.
	90	...	"	P	In course 114—old hole, burst.
	...	91	"	P	Struck low to right of E, about course 35, burst.
	...	92	"	P	Just under crater about course 94 between C and D, burst.
	93	...		...	(Photograph No. 5 taken).
	94	...	Shot	...	Fired in salvo.
	...	95		...	All four struck.
	...	96		...	

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Date.	Gun. 68-pr.	Gun. 32-pr.	Projectile.	Fuze.	Effect.
1860.	Rounds.				
Nov. 12	97	...	Shells	P	Miss?
	98	...		P	
	...	99		P	One miss, one struck to the right of C on course 70.
	...	100		P	
	101	...	"	P	One miss, one seemed to burst in the air about 100 yds. beyond tower; struck low.
	102	...		P	
	...	103		P	
	...	104		P	
	105	...	Shot	...	All hit: 3 low among the rubbish: 1 high in large crater.
	106	...		...	
	...	107		...	
	...	108		...	
	109	...	Shells	P	1 or 2 missed and burst at sea; the others hit very low.
	110	...		P	
	...	111		P	
	...	112		P	
	113	...	"	P	2 hit high, one about course 110 between D and E: 1 low, one doubtful.
	114	...		P	
	...	115		P	
	...	116		P	All burst.
	117	...	"	P	Miss and no burst.
	118	...	"	P	Grazed coping, no burst, sparks seen.
	...	119	"	P	Struck to left of D about course 115.
	...	120	"	P	Miss, burst on graze on sand. (Photograph No. 6 taken).
	121	...	Shot	...	Struck on course 52 above C.
	122	...	Blind shell, filled with powder.	...	Struck in large crater to right—course 95.
	...	123	"	...	In lower crater to left D on course 38.
	...	124	"	...	Miss to left.
	125	...	"	...	Miss to right.
	126	...	"	...	Short and miss to left.
	...	127	"	...	Left of A on course 56.
	...	128	"	...	Struck near C on course 35.
	129	...	Blind shells, with powder.	...	Struck on C about course 115, burst.
	130	...		...	Miss to right.
	...	131	"	...	Miss to left.
	...	132	"	...	Struck top of upper crater about C—course 108.
	133	...	"	...	Miss to left.
	134	...	"	...	do.
	...	135	"	...	Struck course 110 to right of E.
	...	136	"	...	Struck course 90 to right of bottom of large crater.
	137	...	"	...	Struck chimney.
	138	...	"	...	Struck in old crater about course 98 on D.
	...	139	"	...	Miss to right.
	...	140	"	...	Large crater, course 110 on D.
	141	...	"	...	In large crater, course 100 on right of D.
	142	...	"	...	Graze to right on course 70, glanced.
	...	143	"	...	Miss to left.
	...	144	"	...	do.
	145	...	"	...	Struck on E course 15.
	146	...	"	...	Burst to left of B on course 50.
	...	147	"	...	Struck course 100 to left of C.
	...	148	"	...	Miss to right.
	149	...	"	...	Miss.
	150	...	"	...	Left of A on course 51.
	...	151	"	...	Miss to left.
	...	152	"	...	In large crater on course 91.
	153	...	"	...	Left of A on course 80.
	154	...	Live shell	M*	Burst at muzzle.
	...	155	Shot	...	Miss to right, or perhaps glanced.
	...	156	"	...	Struck course 70 between D and E at top of window.

* These fuzes were all of 1851 and 1852.

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Date.	Gun. 68-pr.	Gun. 32-pr.	Projectiles.	Fuse.	Effect.
1860.	Rounds.				
Nov. 12	157	...	Live shell	M*	Miss to left, not seen to burst.
	158	...	,,	M*	Struck on course 70 to left of E, burst.
	...	159	Shot	...	High in large crater on course 90.
	...	160	,,	...	Struck short, ricocheted, and hit low to left of C.
	161	...	Live shell	M*	Missed to left, burst at sea.
	162	...	,,	M*	Burst at muzzle.
	...	163	Shot	...	Struck course 50 on A.
	...	164	,,	...	Struck course 60 on B.
	165	...	Live shell	M*	Burst on course 112 between D and E.
	166	...	,,	M*	Miss to left.
	...	167	Shot	...	Struck course 40 on C.
	...	168	,,	...	Struck course 85 between D and E.
	169	...	Live shell	M*	Hit course 60 to left of B.
	170	...	,,	M*	Burst at muzzle. Moorsoms's fuzes discontinued.
	...	171	Shot	...	Hit very low about B on ricochet.
	...	172	,,	...	The same.
	173	...	,,	...	Struck course 25 between D and E.
	174	...	,,	...	Struck short, ricocheted and struck D on course 12.
	...	175	,,	...	Miss.
	...	176	,,	...	Struck course 52 to left of B.
	177	...	,,	...	Miss to left.
	178	...	,,	...	Struck very low near E.
	...	179	,,	...	Struck 100 yards short, ricocheted and struck foot.
	...	180	,,	...	Struck B on course 57.
	181	...	,,	...	Struck course 30—centrally.
	182	...	,,	...	Hit to left of D.
	...	183	,,	...	Hit foot.
	...	184	,,	...	Struck in left of large crater course 112, brought down part of the coping.
	185	...	,,	...	Miss.
	186	...	,,	...	Hit C on course 60. Struck at foot of B.
	...	187	,,	...	Struck course 60 on C.
	...	188	,,	...	Hit D on course 69.
	189	...	Shell	T	One miss, one in parapet, two in tower.
	190	...	,,	T	Salvo, with time fuzes, brought down a mass of the
	...	191	,,		parapet 5½ feet across inside.
	...	192	,,	T	Miss.
					(Photograph No. 7 taken).
	193	...	,,	T	Struck course 34, and burst well, after a pause.
	194	...	,,	T	Struck coping and burst.
	...	195	,,	T	Burst in sea, miss.
	...	196	,,	T	Struck C about course 90, burst
	197	...	,,	T	Miss, burst at sea.
	198	...	,,	T	do. do.
	199	...	,,	T	In large crater about course 93, no burst.
	...	200	,,	T	Miss, burst at sea.
	201	...	,,	T	Struck the foot between B and C, burst.
	202	...	,,	T	Missed to left, burst at sea.
	...	203	,,	T	Struck course 65 about the doorway, rebounded 50 yards to the left and burst on the ground.
	...	204	,,	T	Struck course 38. no burst.
	205	...	,,	T	Struck course 100 about C.
	206	...	,,	T	Struck course 15 about C. Burst on the ground, a large piece of coping fell to left.
	...	207	,,	T	Burst at sea, miss.
	...	208	,,	T	Struck C about course 68.
	209	...	,,	T	Miss, burst at sea.
	210	...	,,	T	do. burst 2nd bound.
	211	...	,,	T	Struck D on course 15, no burst.
	212	...	,,	T	Miss, burst at sea.
	213	...	,,	T	do. burst 2nd bound.
	214	...	,,	T	Graze near A on course 112, burst at sea.

* These fuzes were all of 1851 and 1852.

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Date.	Gun. 68-pr.	Gun. 32-pr.	Projectile.	Fuze.	Effect.
1860.	Rounds.				
Nov. 12	...	215	Shell	T	Miss, no burst.
	...	216	„	T	Hit course 10 about D.
	217	...	„	T	Struck low to right of E.
	218	...	„	T	Miss, burst at sea.
	...	219	„	T	do. do.
	...	220	„	T	do. do.
	221	...	„	T	do. do.
	222	...	„	T	Grazed to the right of course 92.
	...	223	„	T	Struck course 75 near B.
	...	224	„	T	Struck course 54 near window between D and E.
	225	...	„	T	Struck foot, no burst, burnt out.
	226	...	„	T	Miss, burst at sea.
	...	227	„	T	do. no burst.
	...	228	„	T	Struck B on course 40. (Photograph No. 8 taken).
	...	229	„	T	Struck low to left of B.
	...	230	„	T	Struck to right of C.
	231	...	„	T	Miss to left.
	232	...	„	T	Miss to right.
	...	233	„	T	Struck low to left of B, burst.
	...	234	„	T	Struck at foot of D, no burst.
	235	...	„	T	Struck high to left of A, burst.
	236	...	„	T	do. do.
	...	237	„	T	Miss, burst at sea.
	...	238	„	T	Hit, burst at foot.
	239	...	„	T	Miss to right, and burst at sea.
	240	...	„	T	Struck high near D, did not burst.
	...	241	„	T	Miss to right, burst at sea.
	...	242	„	T	In large crater, burst.
	243	...	Shot	...	Struck at foot of C.
	244	...	„	...	Struck on A.
	...	245	Shell	T	Miss to left.
	...	246	„	T	Miss to right.
	247	...	Shot	...	Struck to left of D.
	248	...	„	...	do.
	...	249	Shell	T	Struck low on D, burst.
	...	250	„	T	Miss to left.
	251	...	Shot	...	Hit in rubbish.
	252	...	„	...	In rubbish at C, miss.
	253	...	„	...	Struck C on course 90.
	254	...	„	...	Struck C about course 100.
	255	...	„	...	Struck on B about course 40.
	...	256	Shell	T	High in large crater, no burst.
	...	257	„	T	In large crater, burst.
	258	...	Shot	...	Struck top of C.
	259	...	„	...	Struck low and centrally.
	260	...	„	...	Struck high to right of crater.
	261	...	„	...	Struck low and centrally—perhaps in the rubbish.
	262	...	„	...	Struck on C about course 40.
	263	...	„	...	do.
	264	...	„	...	Struck near A above course 40.
	265	...	„	...	Struck near A below course 40.
	266	...	Shell	P	Miss to right, no burst.
	267	...	„	P	Hit high in breach, and burst.
	268	...	„	P	Wide to right, no burst.
	269	...	„	P	do. do.
	270	...	„	P	Struck the right top edge of breach.
	271	...	„	P	do.

J. H. LEFROY,
Brevet-Colonel R.A.
Secretary.

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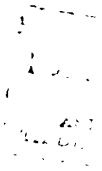

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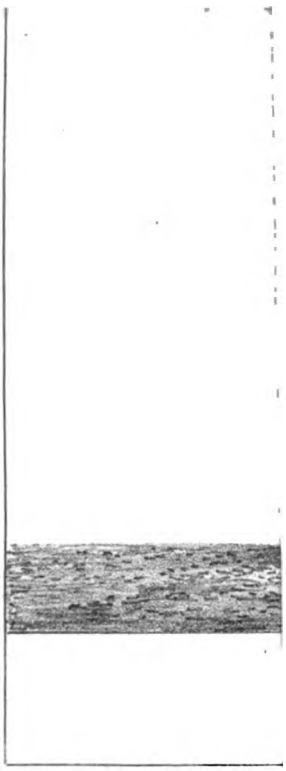

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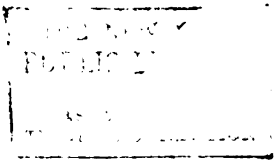

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Annual Report and abstract of Proceedings of a General Meeting of the Royal Artillery Institution, held on Monday, May 13, 1861.

COLONEL DICK, R.A., IN THE CHAIR.

THE Committee of the Royal Artillery Institution have the honor to submit to the Annual General Meeting their Report for the year 1860-61.

The accompanying Table shews the increase and present state of the Institution with respect to Members.

RANK.	£	s.	d.	April, 1860.	Since joined.	Promoted or withdrawn.	Deceased.	April, 1861.
EFFECTIVE LIST.								
General and Regimental Field Officers, paying annually	1	5	0	138	+ 7	— 5	— 1	139
Captains	0	16	0	317	+ 22	— 10	— 2	327
Lieutenants	0	10	0	311	+105	— 22	— 2	392
Quarter-Masters	0	10	0	5	0	0	0	5
Riding-Masters	0	10	0	0	2	0	0	2
Surgeons Major	1	5	0	3	+ 1	0	— 1	3
Surgeons	0	16	0	7	— 1	+ 1	0	7
Assistant-Surgeons	0	10	0	13	+ 5	0	0	18
Veterinary Surgeons	0	10	0	0	2	0	0	2
RETIRED LIST.								
General and Regimental Field Officers	1	5	0	14	+ 1	— 1	0	14
do. ..... do.	0	16	0	1	0	0	0	1
do. ..... do.	0	10	0	0	6	0	0	6
do. ..... do.	0	7	6	15	0	— 7*	0	8
Captains	5	0	0	1	0	0	0	1
do.	0	16	0	21	+ 3	— 13†	0	11
do.	0	10	0	0	8	0	0	8
do.	0	5	0	17	0	— 11‡	0	6
Lieutenants	0	10	0	1	0	0	0	1
				864	+163	— 70	— 6	951
Honorary Members	0	10	6	29	+ 6	0	0	35

* Raised their subscriptions.
† Wrongly entered last year, and disallowed.
‡ 7 raised their subscriptions, and 4 disallowed.

By comparing the whole number of Members at the commencement of the past financial year with the number at the commencement of the present year, it will be seen that the increase amounts to 87; and the Committee cannot but regard the steady advancement from year to year of the number of subscribers as a sure indication of the progress of the Institution in its course of general usefulness.

In submitting the Annual Statement of Accounts for the past year, the Committee have to observe that, no notice having been taken of the outstanding debts in the Annual Abstract of the previous year, amounting to £809 2*s.* 0½*d.*;§ it has been necessary to meet these debts in part by the sale of £500, 3 per cent. consols stock, and by part of the last year's income.

§ From this sum must be deducted about £80 then due to the Institution.

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General Abstract of the Income and Expenditure of the Royal Artillery Institution,

From 1st April, 1860, to 31st March, 1861.

Dr.

Expenditure.	Paid for old Debts due prior to April, 1860.			Expended for the year 1860–1.			Total Expenditure		
	£	s.	d.	£	s.	d.	£	s.	d.
Balance Dr. Messrs Cox & Co., 1st April, 1860							21	14	5
Chemistry	116	9	9	42	5	9	158	15	6
Drawing	31	2	1	12	6	6	43	8	7
Printing — Paper	67	2	9	38	15	3	105	18	0
Printing — Wages				295	8	1¼	295	8	1¼
Printing — Type and Materials	63	1	4	89	3	5	152	4	9
Printing — Lithography	13	7	10	28	6	0	41	13	10
Printing — Stitching, Binding, Materials, &c.	58	14	5	50	7	3	109	1	8
Furniture and Repairs	64	2	0½	23	7	4½	87	9	5
Instruments				3	13	0	3	13	0
Insurance	10	0	0	10	0	0	20	0	0
Library, Books, &c.	116	0	5	58	6	8	174	7	1
Museum	21	5	0	41	1	3	62	6	3
Observatory				3	12	6	3	12	6
Photography	98	8	0	55	14	4	154	2	4
Taxidermy				4	17	0	4	17	0
Carpenter, Wages				22	12	9	22	12	9
do. Materials	68	3	7	32	11	7	100	15	2
Postage and Parcels				21	14	8	21	14	8
Stationery				35	7	4	35	7	4
Transcribers	9	4	8	1	12	0	10	16	8
Wages, Clerk and Orderlies				78	15	6	78	15	6
Incidental				32	10	9¾	32	10	9¾
Dec. 1860, Sale of Stock £500 0 0 / Market value £466 17 6 — £ s. d. 33 2 6							33	2	6
Balance Creditor — Consols Stock							700	0	0
Balance Creditor — Cash							8	17	3
Total	737	1	10½	982	9	0½	2483	5	1
Bills still owing at the close of the year 1860–1861	72	0	2	392	2	6½	464	2	8½

Cr.

Income.	£	s.	d.
Balance Creditor, 1st April, 1860 — Consols Stock	1200	0	0
Balance Creditor, 1st April, 1860 — Cash	2	3	6½
Dividend on Consols (up to 5th January, 1860)	27	6	3
Subscriptions	708	9	6
General Printing	378	15	7
Drawing	6	5	11
Chemistry	40	4	2
Photography	40	6	3
Taxidermy	4	13	2
Carpenter, wood, &c.	11	2	8
Stationery	28	18	11½
Library, books, &c.	31	9	4
Incidental	0	9	9
Arrears received	3	0	0
Total	£2483	5	1
Stock on hand, and Debts due to R.A. Institution	154	19	7

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The expenditure in detail, under each head is shewn in the annexed statement, in which the actual expenses for the year that is now past are kept distinct from the liabilities for the previous year.

Notwithstanding the sale of stock (which realized £446 17*s.* 6*d.*), the burden of the large debt already referred to has imposed upon the Committee a severe economy, the necessity for which is not yet wholly removed. It is confidently expected however that the prospects of the Institution (from the sale of the "Hand Book for Field Service" now in the Press) are such as will enable the Committee during the ensuing year to pay the old debts that are still due, and to cover completely the current expenditure.

The balance Cr of the Institution at the end of the year 1860-61, is as follows:—

	£	*s.*	*d.*
Consols and Cash	708	17	3
Outstanding liabilities	309	3	1½
Balance Cr.	£399	14	1½

Printing and Publication.—The amount of work done in this department is considerable. The "Proceedings" and "Occasional Papers" are still supplied to every Member at home and abroad.

It is the desire of the Committee to render these channels of communication with the scattered members of the corps as useful as possible, by publishing such interesting matter on professional subjects as they may be able to obtain, either from the labours of individual members, as in the case of Major Miller's "Italian Campaign of '59;" or from other sources, as in the Report on the "Eastbourne Experiments," through the kindness of the Secretary of State for War.

The Committee embrace this opportunity of again inviting all Officers who may have it in their power, to contribute papers on professional subjects, to be read at Monthly Meetings, and (when of sufficient general interest), to be printed and circulated throughout the Regiment.

Besides the second edition of Major Owen's "Lectures on Artillery" printed last year, the Institution is engaged upon a third edition (1000 copies) of the same work.

Much time has been taken up with the "Hand Book for Field Service," of which a new edition is in progress, and will it is hoped soon be completed.

Constant demands upon the printing press in one form or another attest the general usefulness of this part of the establishment.

The Committee desire to record their sincere thanks for the liberal kindness of the Right Honorable the Secretary of State for War, in permitting the plans for the "Italian Campaign of '59" to be executed at the Topographical Depôt, and for the grant of lithographs to accompany the Report on the Eastbourne experiments.

A list of the papers issued to Members, during the year, is given below.

Experiments on the Strength and Elasticity of Timber, made in the Royal Arsenal, Woolwich, 1852—1859. By Major H. Clerk, R.A., F.R.S., with Plate.

List and Description of Old Guns and Mortars, English and Foreign, found in the Royal Military Repository at Woolwich, in the Royal Arsenal at Woolwich, and in the Tower of London, with Plate. By Lieutenant Edgar, R.A. M.A.

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A Study of the Italian Campaign in 1859, with 15 Plans. By Major F. Miller, FC, R.A.

Considerations and Suggestions relative to the Magazine, Storage, and other similar requirements of Permanent Garrison and Coast Batteries, with Plate. By Lieutenant-Colonel Nixon, R.A.

Fortification in an Artilleristical point of view. A new system adapted to existing Arms, with 2 Plates. By Lieutenant A. Doull, R.A.

Annual Report and Abstract of the Proceedings of a General Meeting of the Royal Artillery Institution, held on Wednesday, May 30, 1860. Major-General Sir R. Dacres, K.C.B. in the chair.

Military Manufacturing establishments in France. By Colonel Smythe, R.A.

Historic facts, connected with the Regiment, from the Journal of an Officer of the Royal Irish Artillery. By Captain Colomb, R.A.

M. Magnus, on the deviation of Projectiles, Translated from the French of M. Delobel. By Major FitzHugh, R.A.

A new System of Fortification, applied to existing Arms. (Abstract.) Lieutenant Doull, R.A.

Remarks by the Ordnance Select Committee on a series of experiments on Rope Mantlets. Communicated by the Secretary of State for War.

Notes on Matériel as at present issued. By Captain G. Frazer, R.A.

A Table of the Names of the Great Ordnance now used, extracted from "The Complete Souldier," Auctore Thomas Smith, 1628. By Lt.-Col. Clerk, R.A., F.R.S.

Regulations and Instructions for the transport of Troops by Railways to supersede the Provisional Orders of the 16th September, 1851, for the use of the Artillery and Military Train of the French Service. Translated by Lieut. E. McLaughlin, R.A.

On various exigences of Artillery in the Field, by Captain Robertson, late R.A. Communicated by Major-General Sir R. Dacres, K.C.B.

Lists of Deficiencies in Nat. Hist. Museum of, Eggs, Birds, &c.

The Crimea Revisited, Extract from a letter written by Lieutenant-Colonel Biddulph, R.A. By Colonel Lefroy, R.A.

Despatches of Brigadier Crofton, R.A., commanding the Royal Artillery of the Expeditionary Force in China, with Map. Communicated by the Deputy Adjutant-General, R A.

*Special Paper.**

Report of the Breaching experiments at Eastbourne, with 5 Plates. By direction of the Secretary of State for War.

Library.—Additional bookcases have been constructed, and a re-arrangement made of the books, classifying them according to their subjects.

The Committee are much indebted to Major Palmer for the time and labour bestowed by him in the preparation of an excellent catalogue, which cannot fail to be useful.

The Committee have also to acknowledge with thanks, contributions of valuable plans and maps from the Director of the Topographical Depôt, War Department, to whom, and to the Officers of that department generally, the Committee feel much indebted.

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* The distribution of this paper, by direction of the Secretary of State for War, was expressly limited to Officers now serving in the Royal Artillery.

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A list is added of Books, purchased and presented during the year.

Presentations to the Library.

Magnetical and Meteorological Observations, by Major-General E. Sabine, R. A.	1	The author.
National Defences, by General Sir R. Gardiner, G.C.B. and K.C.H. (Copies)	3	do
Course of Artillery and Fortification, by Lieut.-Colonel Boxer, R.A	1	do
Monthly Notices of the Royal Astronomical Society		Captain A. Noble, R.A.
Examination Papers Royal Military Academy, (June and December)	2	Inspector of Studies, Royal Military Academy.
Professional Papers, Royal Engineers	1	Colonel Bainbrigge, R.E.
Treatise on Naval Gunnery, by General Sir H. Douglas	1	The author.
The Right and Priority in the Principle and Method of constructing Ordnance (a pamphlet)	1	R. Mallet, Esq.
Journal U.S. Institution, Nos. 13 and 14	2	The Council.
Proceedings of Royal Geographical Society	1	Colonel Smyth, R.A.
Journal do do 26 and 29	2	
Campagna di guerra, Nell 'Umbria e Nelle Marche	1	Major Middleton, Lancashire Militia Artillery.
Atlas du Magnetisme Terrestre, by Pierre Béron	1	The author.
On the construction of Artillery, by James Atkinson Longridge, M.I.C.E. (pamphlets)	5	Captain A. Noble, R.A.
Artillery in India, 1 and 2, by Lieut.-Colonel John Adye, C.B., R.A. (pamphlets)	2	The author.
Cycle of Celestial objects, by Vice-Admiral Smyth and Dr Lee	1	The authors.
Instructions for taking Meteorological Observations, by Colonel Sir H. James F.R.S.	2	Secretary of State for War.
Annual Report of Instructions in Musketry	1	Deputy Adjutant-General R.A.
Ricordo Pittorico Militaire della Spedizione Sarda in Oriente	1	Major Middleton, Lancashire Artillery.
Photographs	2	Captain R. K. Freeth, R.A.
Cromo Lithograph Drawing	1	Captain Brackenbury, R.A.
Statical Friction, by Dr Rutherford, F.R.A.S. (pamphlet)	1	The author.
Photographs from Royal Gun Factory	18	Secretary of State for War.
do of experiments at Eastbourne	1 Set	do do
Copy of a work in 3 Vols On the Strength, Organization, and Composition of the Armies of Europe, by Captain Martin Petrie, 14th Regiment	3	do do
Military Notes, No. 3, by Lieutenant W. B. E. Ellis, R.A. (pamphlet)	1	The author.
Fencing Familiarized, or a Treatise on the Art of small sword	1	Captain Paget, R.A.

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Journal and Report current, Climate and Navigation. (pamphlet)	1	Captain D. Vaughan.
National Defence, by Colonel Shafto Adair, M.P.	1	The author
Report on the explosion of Gunpowder by Electricity	1	Secretary of State for War.
Hand Book of Chemistry, by Leopold Gmelin	1	Cavendish Society.
Small Plans of Delhi. (copies)	2	The Director, Topographical Depôt, War Department.
Large do ,,	2	
Road from Cawnpore to Lucknow	2	
Plans of General Havelock's Actions	2	
Military Maps of India	2	
Views of Agra	2	
Plans of Lucknow, &c.	2	
do of Sir Colin Campbell's actions at Cawnpore	2	
Maps of N.W. Provinces of India	2	
Maps of Oude	2	
Sketch of Town and Fort of Jhansi	2	
Maps of British Columbia	2	
do of Gwalior District, India	8	
do of Country round Pekin	2	
Plan of a Rifle Range for Volunteers	2	
Map of Pekin and its environs	2	
Plans of the allied positions before Sebastopol	12	
Sketch to illustrate the movements of the Allied Forces in China	2	
Plan of the Country between Pekin and the Gulf of Pechili	2	
Despatches for the above	4	
Plan of Pekin in 1817	2	
Description of the above	2	
Sketches illustrating the action fought 18th September, 1860, by the Allied Armies in China	2	
Maps of the Lombardo Venetian Kingdom, in 4 sheets (2 of each)	8	
Sketch of the engagement at Montebello	2	
Military Sketch of St Helena	2	
Plan of Portion of Line of Telegraph from Constantinople to Bussorah	2	
Battle of Magenta		
Description of do	2	
Plan of City and Suburbs of Canton	2	
Maps of Europe shewing Coal fields	2	
Reports relating to the re-establishment of the Fortresses in the Netherlands	1	Lieut.-General Sir H. Jones, K.C.B., Royal Engineers.
Military Surveying and Sketching	1	Captain Drayson, R.A.
British Fossil Echinodermata from the Oolitic Formations, Part 4	1	Palæontographical Society.
Lectures and Addresses by the late Rev. F. W. Robertson	1	Capt. F. Robertson, R.A., H.P.
Care and Feeding of Cavalry and Artillery Horses in India (a pamphlet)	1	Lieut.-Colonel Adye, C.B., R.A.

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Annual Reports of the Smithsonian Institution 1853 to 1859	6	Smithsonian Institution, Washington, U.S.
Exploration for a Railway Route from the Mississippi River to the Pacific Ocean 2 to 11	10	
Smithsonian Contribution to Knowledge, Vol. I.–XI.	11	
Tables, Meteorological and Physical, by Arnold Guyot, P.D. L.L.D.	1	
First Report of a Geological Reconnoissance, by D. D. Owen	1	
Magnetical Observations in the Arctic Seas, by E. K. Kaur, M.D.	1	
Meteorological Observations of the Arctic Seas, by E. K. Kaur, M.D.	1	
Catalogue of the Described Depteria of North America. R. A. Sacken	1	
Directions for Meteorological Observations	1	
Catalogue of N. American Birds	1	
do do Mammalia	1	

Books Purchased.

Ure's Dictionary, 15 parts, Vols.	3
Aide Mémoire of Military Science	3
Hand Book of Chemistry. Abel and Bloxam	2
Birds of Asia. Vol. XII.	1
Photographic Chemistry	1
Bowman's Chemistry	1
Imperial Atlas of Modern Geography	1
Macdougall's Theory of War	1
Liebig's Familiar Letters on Chemistry	
Reglement sur le Service et les Manœuvres des Pontonniers	1
Histoire du Consulat et de l'Empire. Part XVIII.	1
Etat Militaire du corps de l'Artillerie de France pour l'anné 1860	2
Cours de Physique de l'Ecole Polytechnique	1
Traité de Balistique, par le General Didion	1
Des Armes Rayées à projectiles allongés	1
Instruction de l'Artillerie, par M. Thiroux	1

Publications of Learned Societies. Periodically.

Comptés Rendus.	Journal des Science Militaires.
Spectateur Militaire.	do für die reine Mathematik.
Journal de Mathématiques.	Proceedings of Royal Geographical Society.
Philosophical Magazine.	Journal des Armes Speciales.
Journal of Society of Arts.	

Museum.—During the past year several valuable additions have been made to the Ornithological part of the Museum, the chief of which are a most interesting collection from Captain Haig, R.A., of Birds collected in British Columbia, and one by Captain Tweedie, R.A., from the Mauritius and India, the latter collected in the Himalayas, which have added several Species not previously in the collection of the Institution.

The Committee desire to record their high appreciation of the value of these gifts, which, would have been still further enhanced if they had been

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accompanied by a few short notes,* giving the date of capture, the color of the iris, the legs and feet, the bill or any other naked part, all of which alter so much after the death of the bird, that it is impossible to describe them correctly. Such information would be invaluable in setting up the specimens, as the natural coloring could then be restored. The sex should also be marked upon each, and that in many instances can only be given correctly by dissection.

The collection of British birds is progressing satisfactorily, nearly one hundred specimens having been added during the year, but as they consist of species collected in this locality (embracing most of those to be found in the neighbourhood), its advancement will much depend upon the assistance given by members who are willing, and have opportunity to help it forward.

A collection of gulls and terns in their different states of plumage would be a most valuable addition.

In the collection of eggs there are still many gaps to fill up, and as in all future classification of birds, the eggs will form a most important element in such arrangement, it is most desirable that the collection of the Institution should be as complete as possible, not only in British but also in foreign specimens.

The case of Lepidoptera has been arranged as far as the specimens will allow, it is however still very incomplete, a great number of families not being represented at all; donations in this branch will be most acceptable.

The space in the Institution not allowing the setting up of large mammalia, the skulls of such would however be of great interest; the addition to this branch has been a splendid skull and horns of the ibex (*capra ibex*), presented by Captain Tweedie.

Some interesting specimens of regimental uniforms of an early date have been received. The following is the general list of articles presented during the past year:—

Presentations to the Museum.

Matchlock, Oude	1	Lieutenant C. F. Roberts, R.A.
Steel Bow, Indian	1	
Arrows, do	9	
Powder Flask, do	1	
Swords, do	2	
Dagger, do	1	
Battle Axe, Esquibo	1	Colonel Tulloh, R.A.
Slab of Flexible Sandstone	1	Colonel Lefroy, R.A.
Undress Jacket and Shaco	1	
Wigwam, N. America	1	Dr Spry, Staff.
Game Birds	12	Mr Whitely
Musket Ball (lodged in Book), fired in Paris during the revolution of 1830	1	Captain Robertson, R.A.
Design of a Pouch secure from Rain	1	
Sea Mouse in Bottle	1	Dr Richmond, R.A.
Stag Beetles	2	Captain G. H. A. Forbes, R.A.

* In the collection of Captain Haig some of the specimens had the date of capture and the color of the iris given.

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Birds from British Columbia, (See list, p. 56, Vol. II. Occasional Papers.)	50	Captain Haig, R.A.
Tulwar (Indian)	1	Captain T. B. Strange, R.A.
Swords with Gauntlets (Indian)	2	
Cabul Katar Knife	1	
Water Glass	1	Captain F. Roberts, R.A.
Shells dug up while sinking a Well at Southampton	10	Maj.-Gen. H. W. Gordon, R.A.
Red Grouse, Male and Female	2	Asst.-Surgeon Fiddes, R.A.
12-pr. Segment Shell, complete		Sir W. Armstrong.
12-pr. do in section		
Time Fuze, Concussion Fuze complete and in section		
Ancient Armour		Military Store Keeper, Tower.
Small African Spear	1	Captain N. S. K. Bayley, R.A.
Arab Knife	1	
Full Dress Coat, Royal Artillery, (date unknown)	1	Lieutenant Ramsden, R.A.
Edinburgh Gazette, A.D. 1699	1	Rid.-Mas. W. McDonald, R.A.
Gulf Weed, picked up from the Gulf of Florida		Captain G. W. Holmes, R.A.
Sea Weed encrusted with Coral, from the Bay of Honduras		
Kaffir Pipe inlaid with lead	1	
Remains of Aztec Idols found in a town in the Mexican Provinces		
Alligators Eggs, from a Nest of 45, dug out of the Sands in British Honduras	12	
Indian Ring used to carry Basins and Plates.		
Full Dress Coat, Royal Artillery, 1812	1	Lieutenant Pickard, R.A.
A Diver ("Little Grebe")	1	Ast. Surg. J. L. Hepworth, R.A.
A Russian Tube Box	1	Major G. H. L. Milman, R.A.
Birds { Mauritius	8	Captain Tweedie, R.A.
Birds { India	44	
Skull of Ibex	1	
Eggs, British Birds	19	Purchased.

Birds presented by Captain Tweedie, R.A. from India and Mauritius.

Cat. No.	Species.	Locality.
304	Accipter nisus	India. Himalayas.
330	Lanius ————	,, ,,
313	————	,, ,,
331	Lanius emeria	,, ,,
323	Lanius ————	,, ,,
321	————	,, ,,
325	Turdus	,, ,,
305	Turdus viscivorus	,, ,,
329	Oriolus ————	,, ,,
332	do ————	,, ,,
312	Ruticilla erythroprocta	,, ,,
303	Dicrurus macrocercus	,, ,,
322	Emberiza caniceps	,, ,,
327	do do	,, ,,
333	do do	,, ,,

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Cat. No.	Species.	Locality.
293	Fringilla ———	,, ,,
328	do ———	,, ,,
308	Pastor fuscus	,, ,,
317	do	,, ,,
326	do	,, ,,
324		,, ,,
299	Fregilus ———	,, ,,
334	Garrulus ———	,, ,,
306	Caryocatactes ——	,, ,,
311	Palæornis alexandri	,, ,,
300	Palæornis ———	,, ,,
301	do ———	,, ,,
335	Palæornis erythrocephalus	,, ,,
291	Psittacus ———	Mauritius.
310	Bucco grandis	India, Himalayas.
315	Tragopan hastingii	,, ,,
302	Euplocomus pucrasia	,, ,,
318	do do	,, ,,
307	do do	,, ,,
296	Phasianus albocristatus	,, ,,
297	do do	,, ,,
336	do do	,, ,,
292	Galloperdix ———	Mauritius.
316	Perdix francolinus	India, Himalayas.
295	Perdix chukar	,,
298	do do	,,
309	do do	,,
319	do do	,,
314	Tetraogallus himalayensis	,,
294	do do	,,
285	Charadrius ———	Mauritius.
287	Botaurus ———	,,
288	do ———	,,
286	Strepsilas interpres	,,
320	Tadorna rutila	India, Himalayas.
290	Anas arcuata	Mauritius.
289	Phæton phœnicurus	,,
	Skull of ibex,—Capra ibex	India.

Taxidermy.—A Class was formed under Mr Whitely, and attended with interest by several officers, some of whom made considerable progress in preparing and setting up various birds, &c. It is hoped that their labours may result in the donation to the Institution of specimens of their own preserving when opportunity is afforded them of turning their acquirement to account.

Photography.—The necessity was pointed out in last year's Annual Report for introducing in the Photographic Room an improved system of management by which the more advanced photographers would be less likely to suffer from the inexperience of beginners. This want the Committee have endeavoured to meet by regulations which it is hoped are found to work satisfactorily.

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Mr Greenish continues to give attendance gratuitously once a fortnight, for the whole day, to afford instruction on all points connected with the art, by taking pictures both in and out of doors, and by examining the plates, &c. of those who choose to submit their work to his criticism.

His day of attendance, at present is Tuesday; and it is hoped that many officers will profit by his practical skill and knowledge as a photographer.

Chemistry.—This Class has been maintained without intermission, though with varying numbers, under the direction of Mr Bloxam.

At one time it included those officers who were qualifying themselves for the duties of firemasters.

It is of great importance that this interesting Class should be numerously attended, and the advantage offered to members, both as regards the laboratory itself, and the services of the instructor, are such, that members would do well to consider the ample means they possess of self-improvement in this most interesting science.

Surveying, &c.—Several officers have attended the Surveying Class under Captain Drayson, R.A., among whom a few have attended regularly and for some months.

One officer has received instruction in the use of the transit.

The young officers who joined the regiment from Addiscombe have been employed in making a sketch and reconnoissance of ground in the neighbourhood of Woolwich, and have also been practised in finding latitude and longitude.

Languages.—The French and German Classes have continued without intermission, notwithstanding the changes that constantly occur in the garrison, excepting for a brief period during the departure of the 1st and the arrival of the 3rd Brigade.

Lectures.—Members still enjoy the opportunity of attending the very interesting course of Lectures delivered to the Gentlemen Cadets of the Practical Class in the theatre of the Institution.

These lectures embrace the following subjects:—

Natural Philosophy,
Geology, Mineralogy,
Steam Engine, and Machinery in General.

The Committee have to thank Colonel Hamley, R.A., Professor of Military History at the Staff College, for delivering a lecture on "The conditions under which war is made in modern times," which was followed by another on "Ricochet and curved fire from smooth-bored and rifled guns," by Colonel Wilford, R.A.

Major Owen, R.A., Professor of Artillery, R. M. Academy, also lectured on the following subject:—"The laws which govern the motions of projectiles fired from rifled ordnance, and the advantages to be derived from the adoption of these pieces."

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Several other officers have signified their readiness to afford instruction to their brother officers in this most useful and acceptable manner.

The Committee have to report that, in accordance with a resolution passed at the last Annual Meeting, a circular has been addressed to certain retired members of the Regiment who retired prior to the time when the subscriptions were increased.

Some of these officers have since raised their subscriptions, some have declined to do so, and some have not replied.

It was then resolved,—

I. That the Report of the Committee be read and adopted.

II. Due notice having been given in accordance with Rule XVII., the following alterations were submitted by the Committee:—

Proposed by the Committee and carried,—

That in Rule I., instead of

	£	s.	d.
2nd Lieutenants	0	10	0
All other ranks	1	0	0

the rate of entrance payment shall stand thus,

All ranks	1	0	0

That in Rule III.

1st Lieutenants	0	10	0
2nd do	0	8	0

be altered to

Lieutenants	0	10	0

i.e. referring to the rate of annual subscription.

III. The remaining copies of the "Rules and Regulations" being nearly exhausted, and a reprint being required, a few alterations (chiefly rendered necessary by the lapse of time) were submitted and approved by the General Meeting.

It was also resolved,—

IV. That as the present strength of the Committee is reduced to about one-half of its full number, only one field officer and two members (instead of one field officer and four members) retire by rotation on this occasion; thus preserving a proportion between the present strength of the Committee and the number of members intended to retire annually, in accordance with Rule IV. These officers are,

Colonel Kennedy, Captain King, Captain Hutchinson.

V. That in accordance with the above Rule, Surgeon Fogo, Horse Brigade, retires from the Committee, having served for a period of two years.

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VI. That the following officers be appointed to the Committee, viz.—

Col. C. J. Wright.	Surgeon H. Briscoe.
Col. W. H. Elliott.	Captain H. A. Doyne.
Lt.-Col. H. Clerk.	Captain J. Lyons.
Major C. H. Owen.	Lieut. W. H. Wardell.
Major W. J. Williams.	Lieut. W. G. Stirling.

The Committee for 1861–2 will then stand thus,

PATRON AND PRESIDENT:

General H.R.H. The Duke of Cambridge, K.G., &c. &c.

VICE-PRESIDENTS:

The Commandant.
The Deputy-Adjutant-General.

MEMBERS:

The Assistant-Adjutant-General.
The Secretary Ordnance Select Committee.
The Brigade Major.

Col. C. J. Wright.	Major C. H. Owen.
Col. W. H. Elliott.	Captain T. L. Dames.
Lt.-Col. H. Clerk.	Captain H. A. Doyne.
Lt.-Col. H. L. Gardiner.	Captain J. Lyons.
Surgeon H. Briscoe.	Lieut. G. A. Crawford.
Major C. F. Young.	Lieut. W. G. Stirling.
Major W. J. Williams.	Lieut. W. H. Wardell.

The Secretary.

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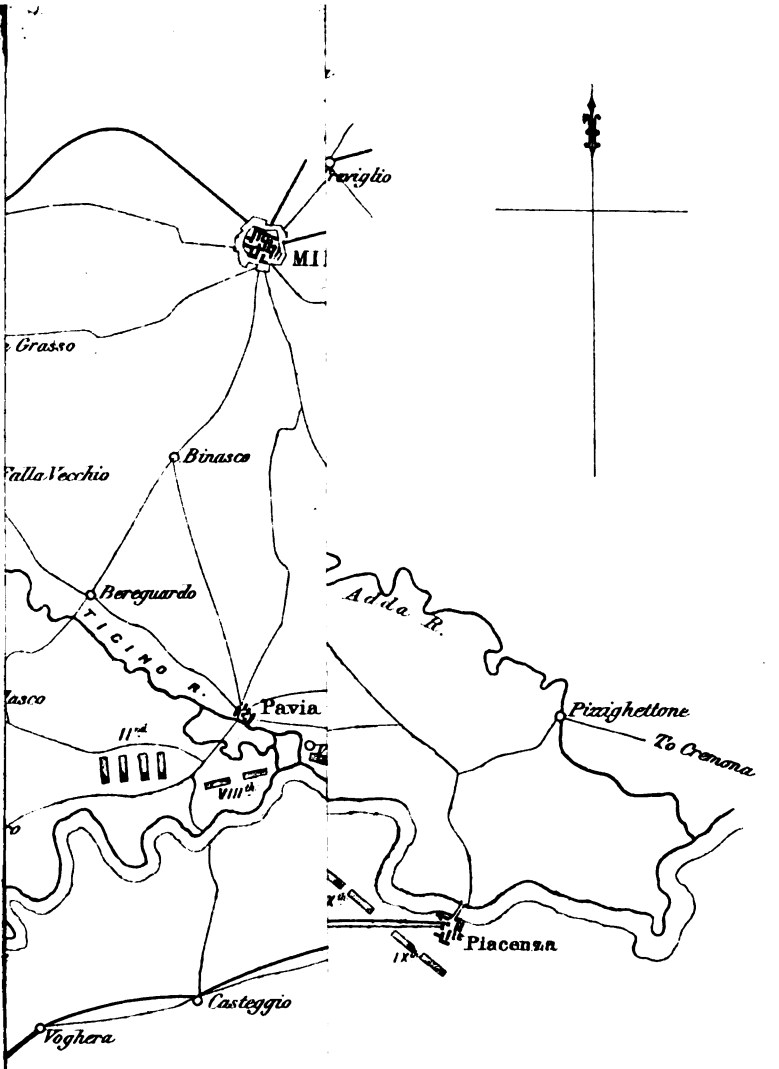

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COL.C GIR H JAMES R.E.D.C.G.M.P. & L. SURVEYOR.

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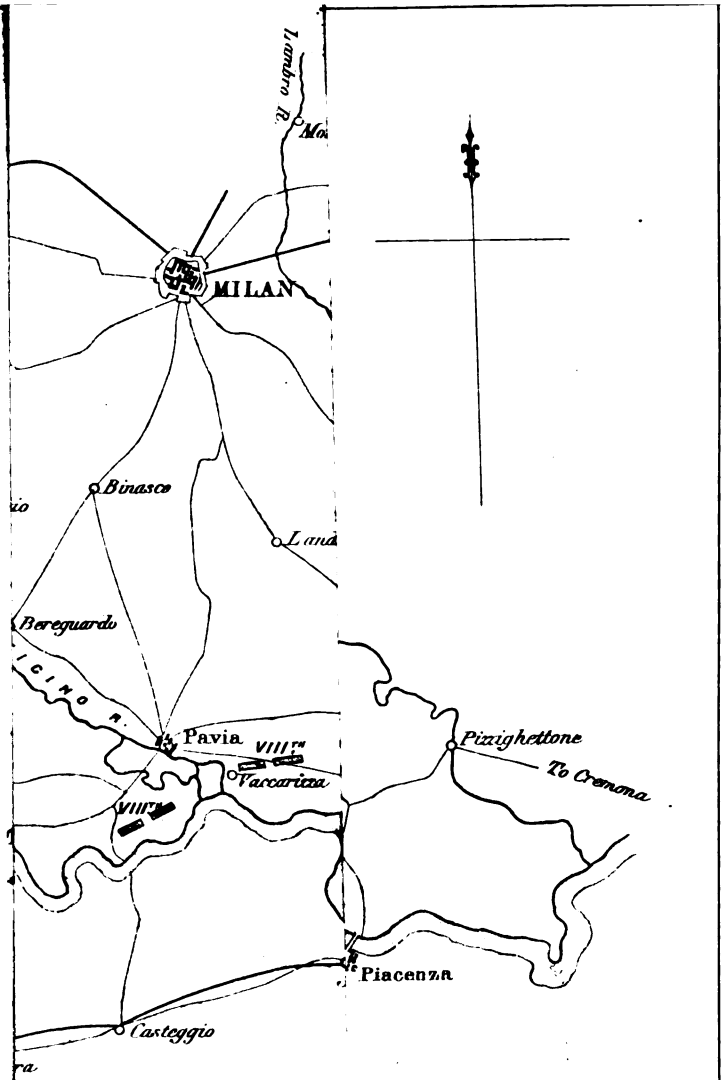

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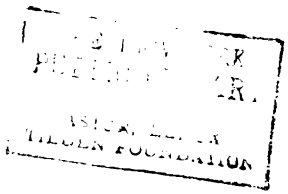
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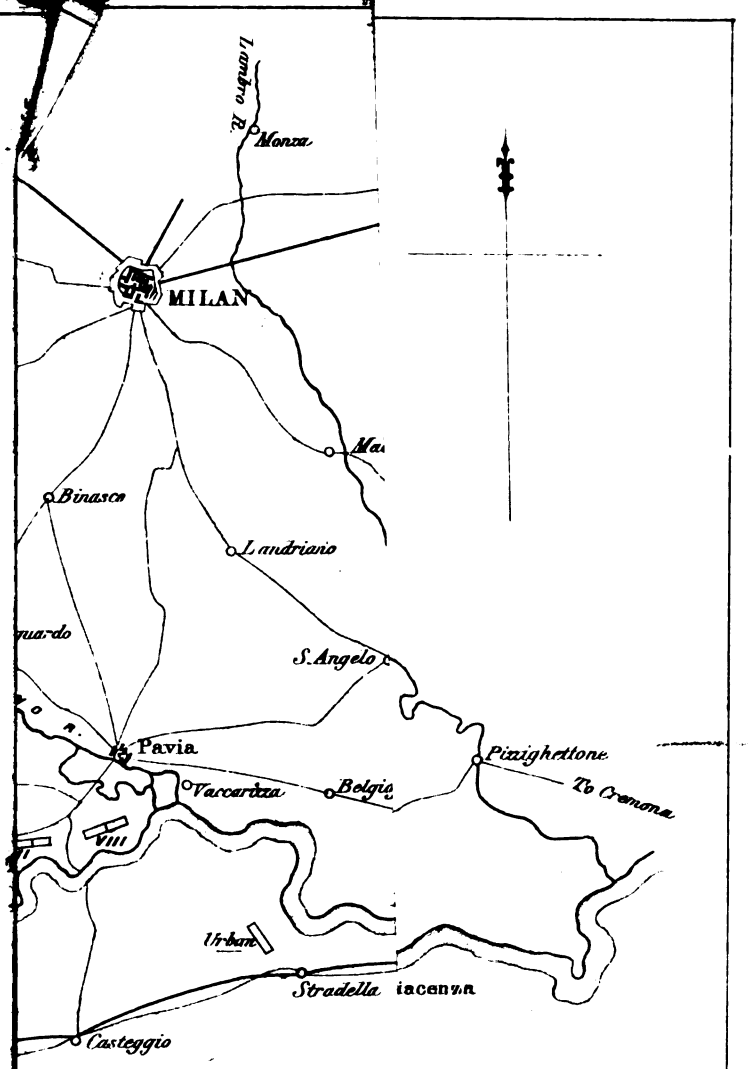

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TOPOGRAPHICAL DEPARTMENT

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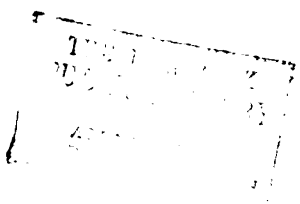

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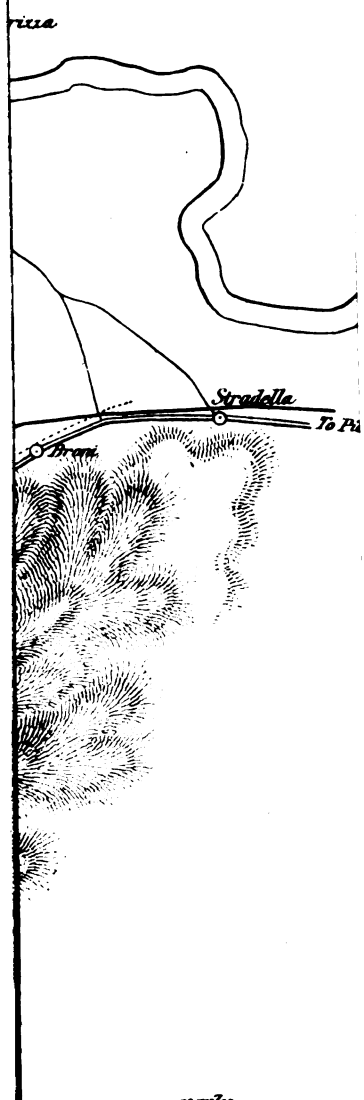

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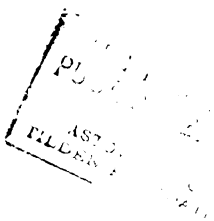

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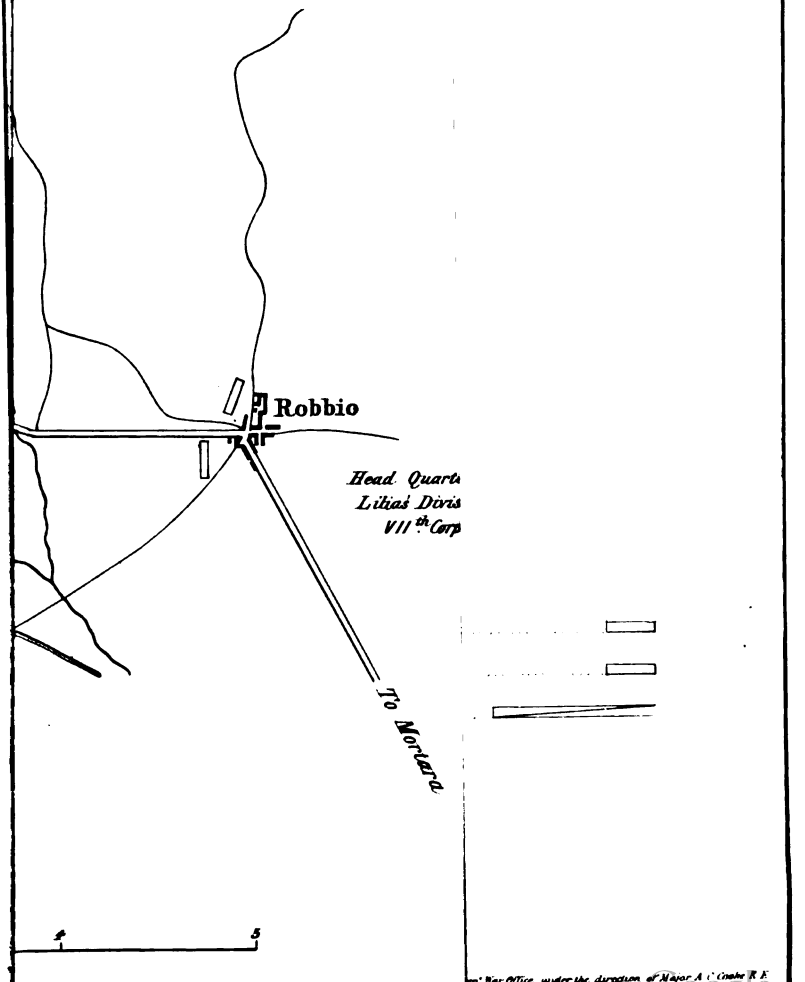

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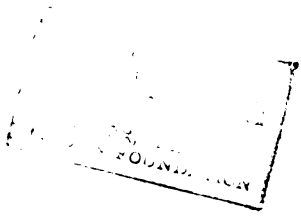

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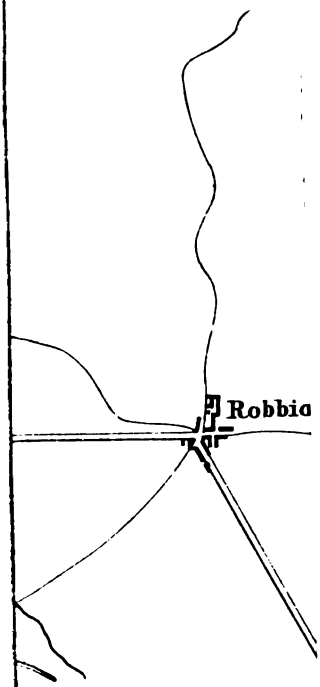

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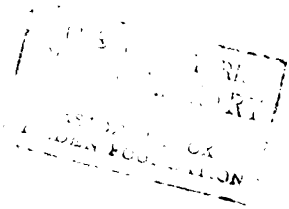

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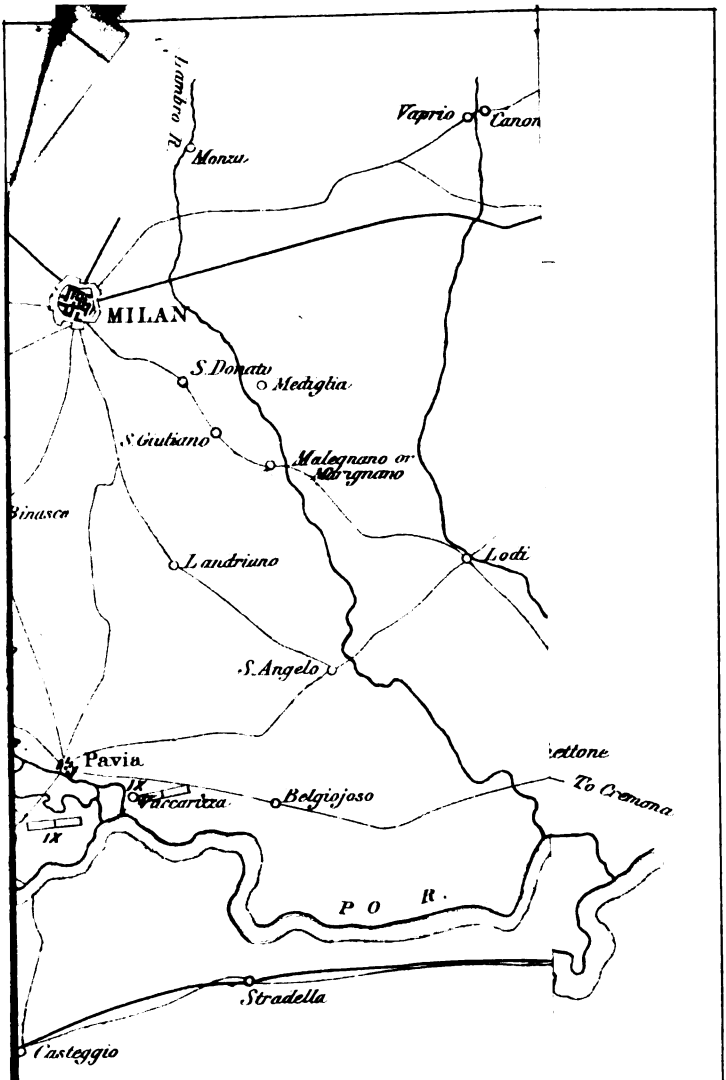

Nº 8.

POSITIONS OF THE AR

1st June, 1859.

During the flank march of the Allie

Scale 30' and or 8 Miles to 1 Inch.

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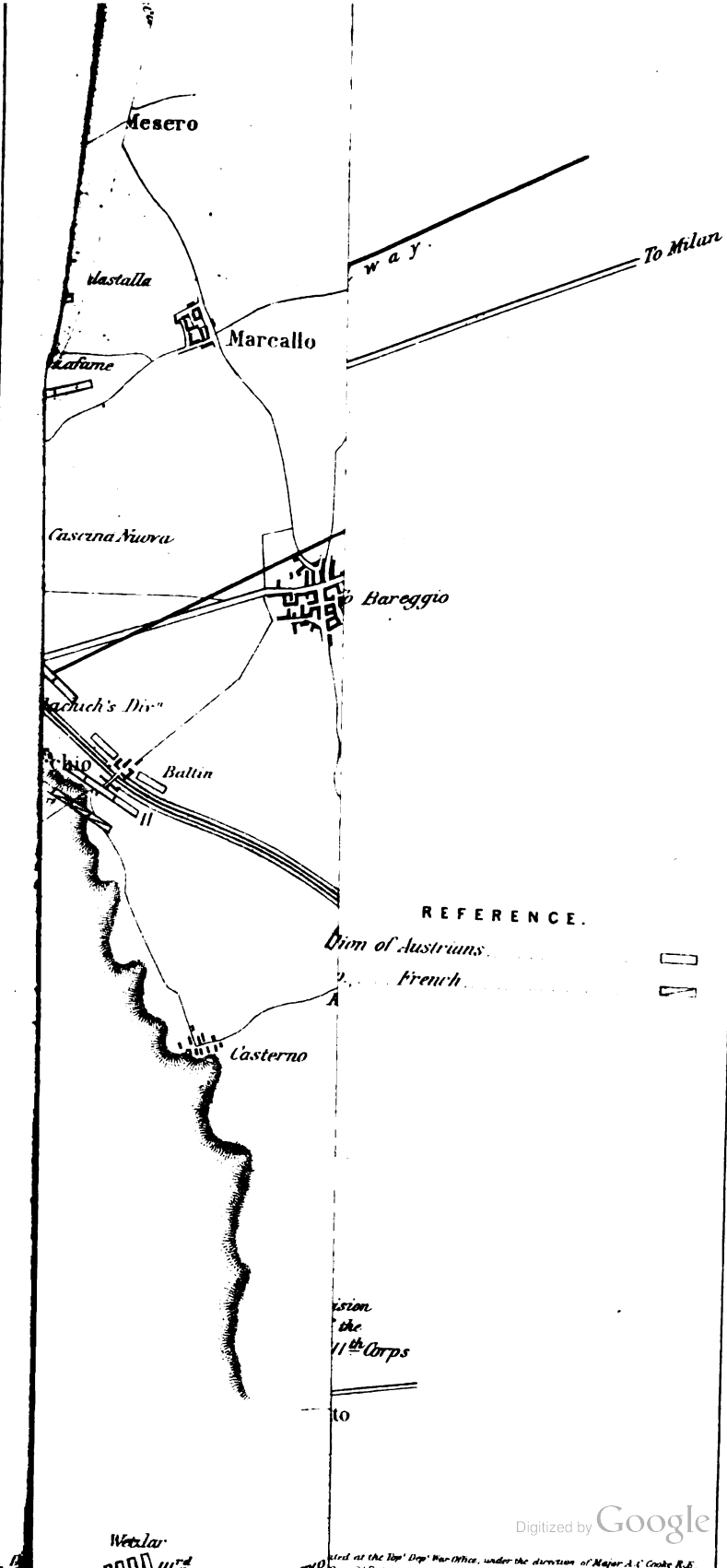

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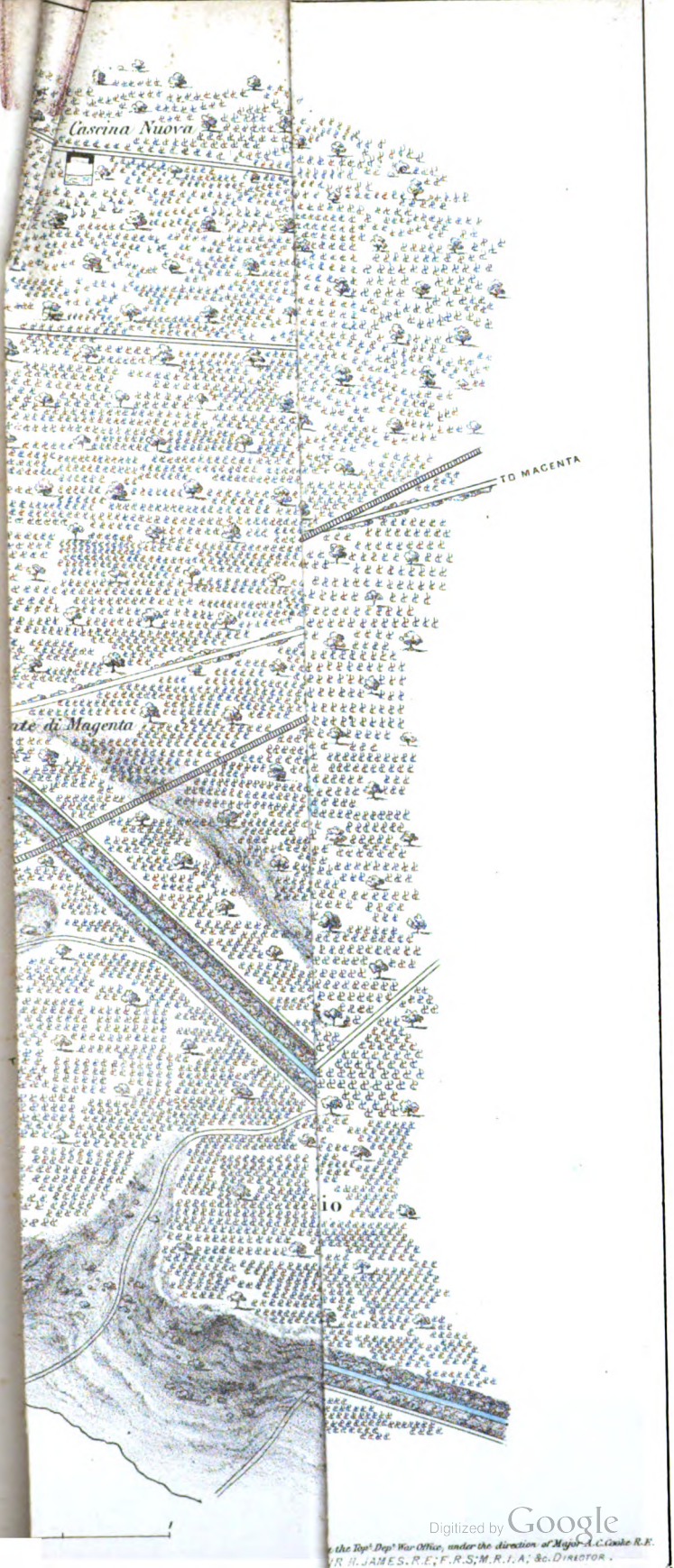

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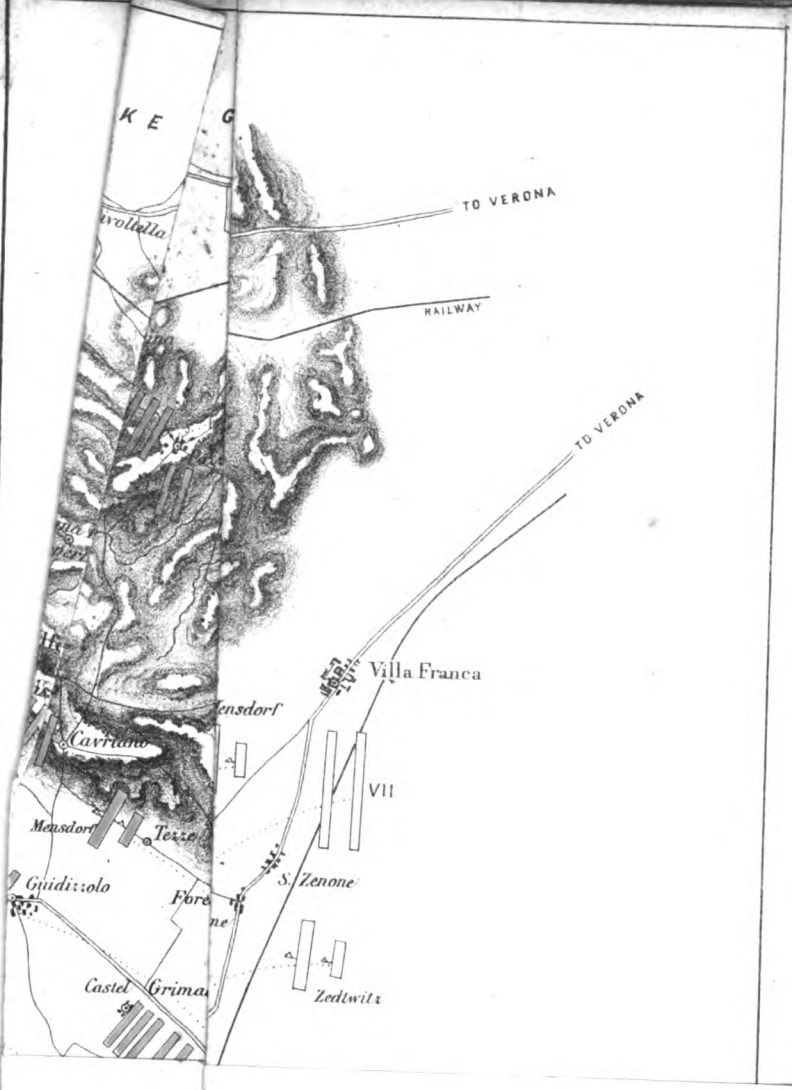

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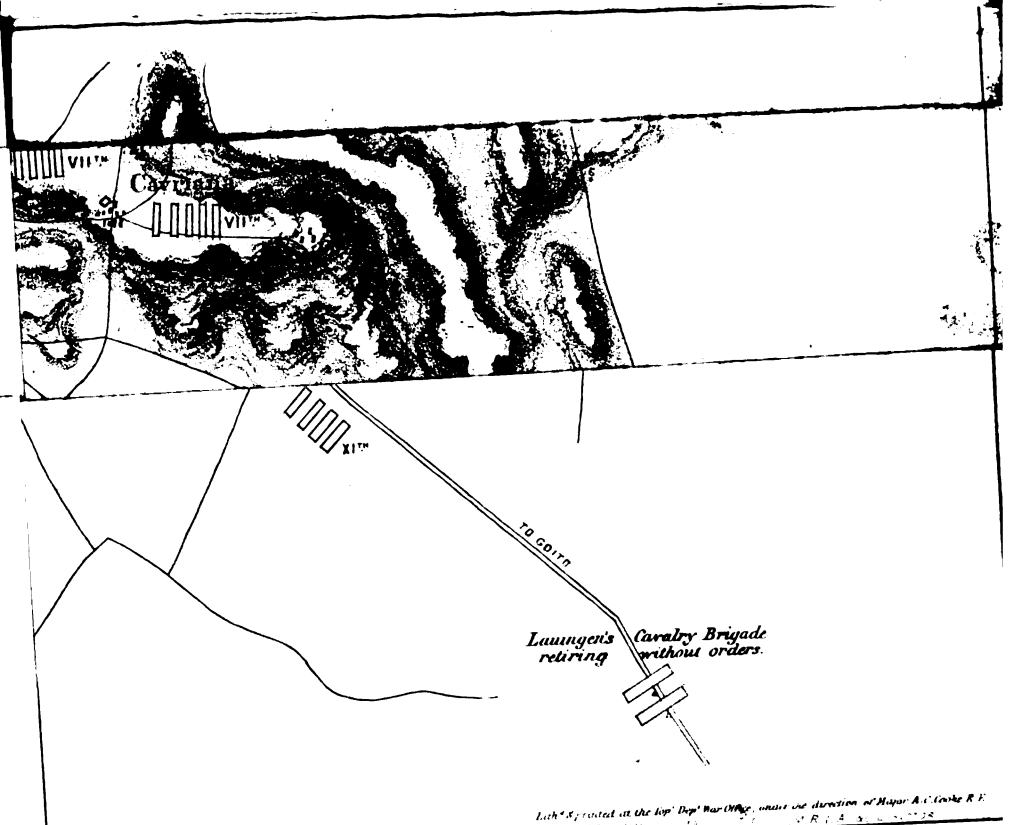

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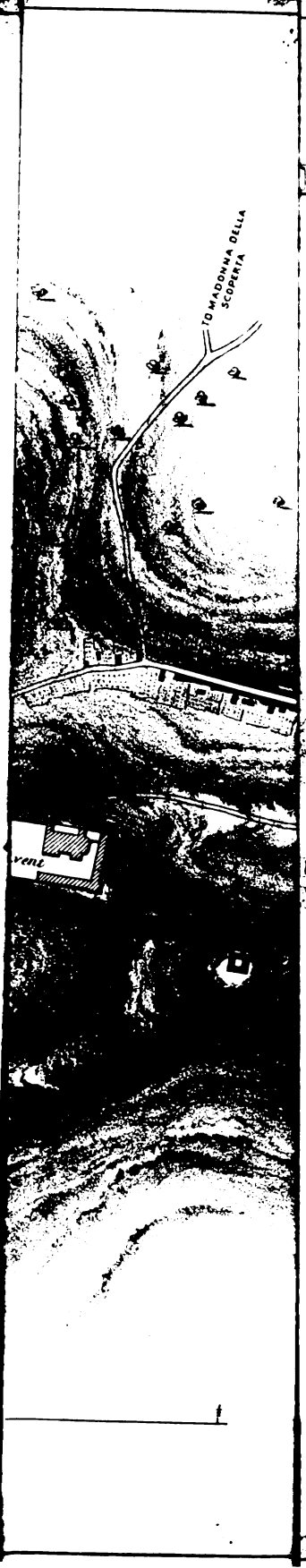

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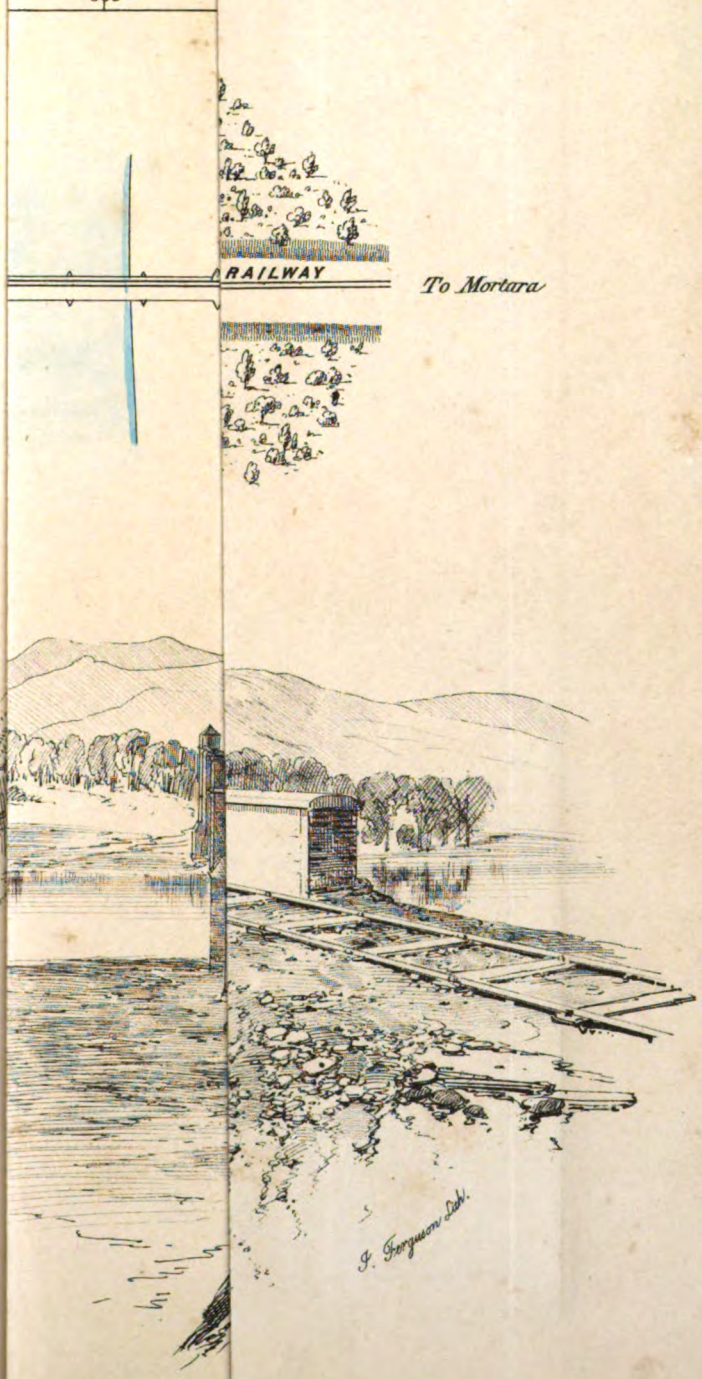

Two Arches ...ade to replace them.

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To accompany Lieut.-Clerk's paper, on the Strength and Elasticity of Timber.

To accompany Lieut.-Edgar's paper on Ancient Ordnance.

Plan of a 12-pr. Gun Battery, shewing the position of the Expense Magazine, Shell store, &c., by Lieut.-Col. Nixon, R.A.

Plates I. and II. illustrative of Lieut. Doull's paper on "Fortification in an Artilleristical point of view.

On determination of distances in the field. Plate I. Explanatory Figures; Plate II. Instrument for measuring distances.

No. 49, Martello Tower, Bexhill. Plate I. Plan and two elevations of Tower; Plate II. Aspects of the Tower at different periods of the practice.

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Report of Ordnance Select Committee, on a Breaching Experiment against Martello Tower, No. 71, near Eastbourne. Communicated by direction of the Right Honorable the SECRETARY OF STATE FOR WAR.

SPECIAL PAPER

The distribution of which, by direction of the Secretary of State for War, is expressly limited to Officers now serving in the Royal Artillery.

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1. THE Committee have the honour to report that, in compliance with Mr Herbert's instructions, they have carried on experiments with a view to the demolition of Martello Tower, No. 71, and have so far completed them as to be in a condition to make a preliminary report on the advantages of some of the heavy Armstrong guns for breaching purposes.

2. The tower in question (No. 71) was built in the year 1804, and is stated to have cost £3,000. It is of brick, able to accommodate 20 men, with magazine space for 80 barrels or 70 cases of powder. Like all the Martello Towers on this part of the coast, it is designed for one gun. The wall on the side fired at is 7 ft. 6 in. thick at the level of the ground, and 5 ft. 9 in. at the spring of the vault, which is 19 ft. from the ground. It is 31 ft. 6 in. high, but receives considerable support, at 12 ft. above the ground, from the joists of the floor, which radiate from a central pillar, and abut against it. To a certain extent, also, the basement floor, at 2½ ft. above the ground, may be regarded as a support. In appearance, the tower was perfectly sound, the brickwork having been protected by a coating of plaster. The parapet, 5½ ft. high and 5 ft. thick, was coped with Bramleyfall stone, in blocks containing 7 or 8 cubic feet; a step 2 ft. high, round the interior, served the double purpose of a banquette and of a support for the front racers of a rear pivot-traversing platform turning the entire circle. The racer itself was laid on granite curb-stones of about half-a-ton weight each. Thus a great solidity characterized the whole structure. The roof was formed of a bomb-proof vault, supported in the centre by a pillar 4 ft. in diameter, turned in three courses of bricks, and surmounted by an equal thickness of ordinary brickwork, giving altogether about 5 ft. of masonry over the crown of the arch. The diameter of the whole at the top was 40 ft., and nearly 46 ft. at the bottom. The shingle extends more than half-a-mile beyond the tower on the land side, and the sea washes the foot of it at high tide. A broad black line was marked horizontally round the land side of the tower, at 9 ft. from the ground, and three similar vertical lines marked on the face fired at. As a further assistance to the record, every tenth course of bricks was numbered, in conspicuous figures, in four vertical rows.

3. The spot chosen for the position of the battery was a slightly-rising ground beyond the turnpike-road from Eastbourne to Pevensey, on Hoisey Farm, and 1,032 yards distant from the tower. Here, by an arrangement with the proprietor,

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a sufficient space was inclosed, and three platforms laid, on which the three following Armstrong breech-loading guns were mounted :—

(1) 82-pr. of 6 in. calibre. Charge for shot, 10 lbs.; for shells, 9 lbs.*
(2) 7-in. howitzer, throwing 100-pr. shells. Charge, 9 lbs.
(3) 40-pr. of 4·75 in. calibre, No. 101. Charge, 5 lbs.

4. The fire was opened at 8 a.m., on the morning of August 7, 1860, in accordance with the programme annexed (Appendix I.), commencing with solid shot from the 40-pr. and 80-pr., and plugged shells from the 100-pr. 12 rounds were fired, of which 11 took effect, as follows :—

TABLE I.

40-pr.	7-in.	82-pr.	Effect.
1	...	...	Struck course 50, and penetrated to a depth of 4 feet, point foremost.
	2	...	Struck the shingle about 65 yards short, and ricochetted over the tower with a noise which indicated that it was turning over.
		3	Struck the shingle about 25 yards short, and, on rising, struck the tower at the 33 course, or 8 feet 3 inches above the ground; entered point foremost and penetrated 3 feet 2 inches.
		4	Struck 50 yards short, passing through the wall of a screen thrown up for rifle practice. It was not distinctly seen, but probably struck the tower about course 69, near Nos. 6 and 9.
	5	...	Struck on course 60, near No. 1; and penetrated 4 feet 3 inches. These two shots (Nos. 1 and 5) caused a displacement of masonry over an irregular area of 5 feet by 5 feet, and to a general depth of two or three bricks.
6	...	...	Struck on course 65, penetrated 3 feet 11 inches, making a hole of 2 feet 6 inches by 1 foot 8 inches, with superficial displacement of ten courses.
		7	Struck on course 50, on the new brickwork which closed the doorway. This brickwork was laid in cement, and had been finished about six weeks. The shot penetrated the wall, which was 7 feet 6 inches thick, at the junction of the old and new surfaces, which were not bonded together, glancing a little downwards. It broke out about eight bricks on the inside, belonging to three courses, and was lying on the floor. The hole externally was about 2 feet in diameter.
8	...	...	Struck course 90, penetrated 5 feet 5 inches, disturbed eight courses, and broke away the surface over an area of 2 feet 3 inches in diameter, and to a depth of 9 inches, beyond which the hole was regular.
	9	...	Struck course 67, and penetrated 3 feet 2 inches, breaking the surface of seventeen courses over an area of about 4 feet by 3 feet 6 inches.
		10	Struck sound brickwork on course 92; passed through the wall 7 feet 6 inches thick, struck the centre pier, and lodged itself in the floor at the foot of the pier. The superficial effect did not extend so far as in other instances; the brickwork was broken over an area of 2 feet 9 inches by 2 feet 6 inches; the hole clean.
11	...	...	Blind shell. Struck course 80, and penetrated 4 feet 2 inches, surface broken over an area of 1 foot 7 inches by 1 foot 6 inches. There were now three large cracks running vertically downwards from the coping.
		12	Blind shell. Struck course 28, and penetrated 4 feet 3 inches, disturbing twelve courses, and breaking away the bricks over a surface of 2 feet 6 inches by 3 feet.

* Reduced at the 20th shell, and 99th round, to 6 lbs. 12 oz.

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5. The brickwork was cracked through by the first six shots, and three or four courses were very slightly, but perceptibly, started inwards. This was the only effect visible inside the tower, except where the 7th shot had penetrated. The cracks were very fine, scarcely traceable, but extended in two or three irregular lines from three feet above the floor to the spring of the arch, and seem to have been produced by the first and fifth rounds.

6. After taking photograph No. 2, the firing was resumed with live shells; seven rounds were fired from each piece, one 6-in. shell (No. 30) burst prematurely, as did four others subsequently, an effect which may be attributed either to the interior having been left in too rough a state, and the consequent ignition of the bursting charge by its friction in the shell, or to the shell being of insufficient strength, or to defect of the fuze; further experience alone can decide positively to which of these the effect is attributable, but probably in some at least of the cases, it was the first cause, which can be remedied by the adoption of a different interior coating.

7. The following is a detail of this part of the practice, at which His Royal Highness the Commander-in-Chief was present.

TABLE II.

40-pr.	7-in.	6-in.	Effect.
13	...	...	Live shell, bursting charge 2½ lbs. Struck course 90, penetrated before bursting about 5 feet, making a crater 12 feet wide at the surface, diminishing to 2 feet at the depth of two or three bricks. Inside the tower the wall was considerably shaken, and seven courses of bricks broken away.
	14	...	Live shell, bursting charge 8 lbs. Struck course 68; penetrated 4 feet.
		15	Live shell, bursting charge 5½ lbs. Struck course 68 within the crater of the last shot; penetrated about 4 feet. These two shells broke the courses from No. 45 to No. 90 over a width of 10 feet.
16	...	...	Live shell. Struck course 32; penetrated 2 feet 9 inches, making a crater of about 3 feet external diameter.
	17	...	Live shell. Struck course 48 in sound brickwork; penetrated 4 feet 3 inches, producing superficial injury over 5 feet 9 inches in width and 9 feet 9 inches in height.
		18	Live shell. Hit in the crater of 17. The total quantity of brickwork displaced up to this time was estimated at about 9 tons, or 162 cubic feet. None of the shells had penetrated the wall; the two first bulged it on the inside, and it was generally much shaken.

8. The tower was not examined until after the 27th round, when it was found that the surface was broken from the 70th course to the 110th course of bricks, and over a width of 18 ft.; at about the 72nd course, a large opening appeared in the wall, immediately under the spring of the arch, the brickwork of which was visible from the outside. The crater formed by the 7th round, near the doorway, had been much increased, and now extended from the 45th to the 80th course over a width of 8 ft. The 27th round (a 6-in. shell) grazed the nearer side of the embrazure of

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the west window, and buried itself in the opposite side, where it penetrated 1 ft. 6 in.; the explosion occurring in an open window, did comparatively little damage. The interior, however, was much dilapidated, and daylight was visible through three openings, viz. the one made by the 7th round, a large hole between courses 70 and 80, and a smaller one rather higher up and to the left of it. The next 6 rounds to the 33rd were fired in two salvoes, and had the effect of enlarging the three openings into a breach about 12 ft. 6 in. wide, and 10 ft. high, externally. The central pillar was fully exposed. A quantity of debris had been carried in sufficient to cover about one-fourth of the interior; there was a settlement of about 2 in. in the portion of the parapet immediately over it, and besides the two cracks between which this settlement was observable, there was a third crack visible about 3 ft. to the left, and the brickwork had started outwards from the granite curb or racer stones between 2 and 3 inches. It was observed, however, that the roof was still undisturbed, the asphalte not even being cracked.

Photograph No. 3 was taken at this stage.

9. From a desire to spare the 7-in. shells, of which only 20 had then been provided, the fire of that gun was now stopped, and the practice resumed with the 40-pr. and 6-in. gun. Seven solid shot and 2 shells were fired from the former, and 9 shells from the latter, 2 of which burst within 50 yds. of the muzzle of the gun. The 38th shot struck the central pillar and carried nearly half of it away. The 41st shot brought down a large mass of the parapet, exposing the granite curbstones and racers. The practice of the first day terminated at 7 p.m., at the 51st round, of which 47 took effect.

10. The appearance of the tower at this stage is exhibited by photograph No. 4, which was taken the following morning. The breach was 13½ ft. wide on the inside, and 24 ft. wide on the outside; the interior was completely open from about 16 ft. above the ground to the top, exposing the top of the central pillar, of which less than half remained, the circumference being reduced in one part from 14 ft. to 8 ft. 4 in.; about 4 ft. of the still remaining wall was a mere shell, kept up by the rubbish and debris behind it. The unsound part of the wall extended about a foot and a half on either side, beyond the inner edge of the breach, which was well defined; beyond this distance the wall was almost undisturbed. The opening in the parapet was 15 ft. 8 in. wide, one granite racer stone had fallen, two more were only held up by the iron racer, a fourth had started 2 inches, the rest were undisturbed. A coping stone containing 7 cubic feet had been thrown about 20 feet from its position. One 80-pr. shell had entered the doorway of the small stair which is made in the thickness of the sea-wall, about 18 inches below the coping of the parapet, and had exploded on its course through, knocking away the outside stone with a portion of the brickwork. The splinter marks inside the tower were numerous, but not very deep; one 40-pr. was found bedded in the brickwork, which the point had penetrated to a depth of 3 ft. 2 in., the other marks were little more than bruises, and did not weaken the wall to an appreciable extent.

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11. The practice was resumed on Wednesday, 8th August, under very unfavourable circumstances of weather; the rain falling in torrents, with a strong south-west wind across the range.

The first 8 rounds carried the breach downwards, but it was not until the 20th, or the 72nd from the commencement, that the central pillar was completely knocked away, and so excellent was the quality of the brickwork, that it continued to sustain its own weight and that of the centre pivot-stones, with the 6-pr. iron gun which formed the pivot, until the 144th round.

In the course of the morning a further supply of twelve 100-pr. shells arrived from Woolwich, and the 7-in. howitzer was fired again alternately with the other two guns from the 69th to the 136th round, when the shells were exhausted.

The state of the weather was such, during nearly the whole of this day, that the Committee did not require the range party (which was sheltered at the next tower), to go in, until it was concluded. This occurred at 6 p.m., when the limited quantity of ammunition which had been provided was exhausted.

The state of the tower at this stage is exhibited by photographs Nos. 5, 6, 7, 8, and may be described as follows:—

12. The parapet was demolished for a distance of 63 ft., measured on the exterior circumference. From hence the opening contracted to an external width of about 35 ft. at the top of the breach, which was 20 ft. above the ground, with a tolerably good ramp. The opening was about 24 ft. wide in the clear inside. Very little of the vaulting remained. The interior face and superior slope of the parapet on the sea front, which was taken in reverse, were greatly shattered, but no effect was visible on that side externally, except from the 6-in. shell already referred to, which penetrated the parapet. The few shells which struck the inner surface below had not broken the plaster outside. The effect visible on this surface was the formation of a regular excavation in the wall from one to two feet in depth, where some flues had been formed in the solid, but with no rents or cracks around it. There were also numerous superficial bruises from splinters of shells. It was observable, generally, that the brickwork shewed very little tendency to crack, or start, or break away in large masses; some of those which strewed the beach, and derived principally from the vaulting, were, however, large enough to have required breaking up before it could have been prudently stormed. The debris extended about 28 ft. to the front; one piece of the stone coping, of about 1 cubic foot, was thrown, by the bursting of a shell, 35 yds. from the tower; another, of 2 cubic feet, 18 yds.; fragments of brickwork were found as far as 150 yds. from the tower, and within 80 yds. they were numerous. It was calculated that about 6,500 cubic feet of brick and stonework were displaced by the fire, amounting to about 362 tons in weight. This was effected at the expense of 1,200 lbs. of powder in cartridges, and 650 lbs. in bursters for the shells. The weight of iron thrown was 10,850 lbs. It has been calculated that 10,600 24-pr. shot are necessary to make a practicable breach 100 ft. wide in masonry, of average quality,

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from a distance of 500 yds.,* which would require about 84,800 lbs. of powder. One-fourth of this quantity may be taken for the purpose of comparing effects in the present case, the breach being, in point of extent, about one-fourth of such a breach as is supposed, but the quality being also inferior, it will be proper to reduce this one-fourth still further, and the Committee assume one-sixth as the basis of comparison.

	Iron.	Powder.
Smooth-bored guns, averaging 24-pounder calibre, and weight 50 cwt., at 500 yards, against rubble masonry	lbs. 42,400	lbs. 14,133
Rifled guns, averaging 80-pounder calibre, and weight 50 cwt., at 1,032 yards against brick.....	10,850	1,850

13. But it must also be borne in mind that the greater part of the expenditure at Eastbourne was occasioned by the 5 feet of vaulting in the roof of the tower, which it was desired to demolish. A breach 20 feet wide, measured on curve, was open at the 41st round, where the entire side had fallen, and a very few more shells then directed to breaking up the fragments of brickwork, and smoothing the ramp, would have made it practicable, especially if there had been an earthen rampart or parapet to furnish material to cover them.

The expenditure of ammunition up to this point was only—

Iron .....2,953 lbs., against 42,400 lbs. of 24-pr. shot.
Powder..... 511 lbs., against 14,133 lbs.

when compared with a battery of 24-prs. firing solid shot.

14. The precision with which the guns could be directed upon any point it was intended to strike gave them advantages with which no smooth-bored ordnance, firing from such a distance, could compete; and the same circumstances would have rendered it almost impossible to retrench or defend the breach, for the fire might have been continued with perfect safety to the assaulting columns until they were within a very few yards of it, sweeping away all obstacles as fast as they could be laid, and without the slightest interruption from the musketry of the defenders, the battery being quite out of their range.

15. The Committee have the satisfaction of reporting that the service of the three battering Armstrong guns was conducted with ease. There was no attempt made to fire with great rapidity, but the general impression of the Committee was that a round per minute might have been delivered from each gun with nearly the same precision, if it had been necessary.

16. Greased wads were employed, with a dry sponge; but the wet state of the guns and carriages on the second day made the operation of loading dirty beyond

* Aide Mémoire, Art. Breach.

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measure. The Committee having provided canvas frocks and overalls, the men's clothes were, in this instance, preserved from destruction; but this peculiarity of breech-loading guns is one which appears likely to call for serious consideration hereafter, and to render it necessary to make some special provision for the preservation of the gunners' clothing.

17. One 40-pr. shell and five 6-inch shells burst a little way in front of the guns. In all probability this result was due to one of the causes before mentioned.

18. As a matter of precaution, spectators were not allowed to approach the tower within 500 yards. Splinters of shells were picked up on the shingle in various directions, at 200 and 300 yds. distance. Some fragments of the shells which burst near the muzzle of the guns, ranged over 100 yds.

19. The percussion fuzes employed were too delicate for this service. Many of them exploded with comparatively little effect in grazing or passing through the debris; few, if any, of them penetrated the brickwork before explosion far enough to exhibit their full power. This can easily be remedied by a modification of the fuze, which is at present better adapted for use against ships than masonry. The quality of the brickwork and mortar was first-rate; the resistance of the vaulting more particularly elicited much admiration. It held up, as already stated, long after the supporting pillar was knocked away, and only yielded to repeated direct blows, such as could not have been given at that distance by any other than rifled guns.

20. The Committee have arranged with the Commanding Engineer to have the whole of the debris cleared away, when there will remain enough sound brickwork for any further experiments Mr Herbert may think fit to direct.

21. The annexed memorandum, furnished by Captain Schaw, R.E., describes the operations of the electric telegraph, from the use of which the Committee derived great advantage. It superseded, in great measure, the use of mounted orderlies. The wire was cut by a splinter of a shell about 1 p.m., on the 8th, but the communication was restored in five minutes, and no other difficulty occurred.

W. T. WISEMAN,

Vice-President.

WOOLWICH, Sept. 8, 1860.

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APPENDIX.

No. I.

Programme for the Proposed Experiments at Eastbourne.

1. The object of the experiment is to ascertain the effect of Armstrong's heavy projectiles against old brickwork.

Taking the best old rubble masonry as unity, the French tables give:—

Penetration into inferior stonework.....	1·25
Penetration into brickwork	1·75

Consequently, the resistance of this brickwork may be expected to be little more than half that of rubble masonry.

2. The stores provided are:—

	7-in.	6-in.	40-pr.	Total.
Common Shells	20*	50	50	120
Solid Shot	0	20	20	40

Distance will be 1,032 yards.

3. It is proposed to begin with solid shot and blind shells, to ascertain penetration.

The tower to be divided into three targets, one for each gun.

Range Officer to be provided with three white boards 2 × 2 feet, to be suspended by cords from the parapet, and shifted, after each round, to the exact spot to be aimed at next, with a view to get as many shots as possible into the sound places before firing shells.

4. Each shot-hole to be carefully probed with iron rods, using a ladder where necessary.

5. The fire to be continued until three good hits of each nature have been obtained, and discontinued as each gun completes that number.

6. Then a photograph to be taken.

7. The state of the interior to be recorded after every three hits, one from each gun.

8. Three rounds will be then fired, with blind shells, from each gun, to compare their penetration with that of the shot. Effect to be observed as before.

9. Then commence with live shells.

The rubbish to be previously cleared away if moderate in quantity.

10. Should the result of a few rounds be to bring down the rear of the tower in large masses, a photograph to be taken, and then shells thrown to break up these masses.

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* Twelve more 100-pr. shells were subsequently provided.

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11. If the front or sea face of the tower, which is the thicker side, continue erect, the Committee will fire solid shot, as before, into it, for penetrations.†

12. Then fire shells into it for destruction.†

13. Photographs to be taken on the completion of the demolition, and at the end of each day's practice.

Minor Arrangements.—No one to be admitted within the sentries without a card, except Officers in uniform. No one within the battery itself, or the tower fired at, except the Committee and Officers attending officially.

A placard to be posted on the day of commencement, for direction of the public.

No. II.

Memorandum with reference to the Electric Telegraph used at Eastbourne, on the 7th and 8th August, 1860, *during Experimental Practice with Sir William Armstrong's Rifled Guns against No.* 71, *Martello Tower.*

The electric telegraph stores sent to Eastbourne were as follows, viz. :—

No. 16 gauge copper wire, covered with gutta-percha, on a drum	1 mile.
Single needle instruments	3
12-cell gutta-percha batteries, Varley's pattern	3

Colour-serjeant Greig, R.E., and three sappers, were sent from Chatham in charge of the apparatus, and to put up the line and work the telegraph. Captain Schaw, R.E., was directed to superintend the operations.

Two long poles, 25 feet long, a number of hop-poles, a ladder, and some spun yarn, were also provided on the spot, and two labourers assisted the sappers in carrying the poles, &c.

The wire was carried parallel to the line of fire of the guns, and about 30 yards distant from it, one terminus being in a tent in rear of the guns, the other in a small brick building (a latrine) close to No. 71 tower. This small building, having only 9-inch walls and a tiled roof, was not considered splinter-proof; the sapper telegraphists, therefore, retired with the range party after each examination of the tower, and after telegraphing up the result to the battery. To save time, the instrument was left in the building, there being a spare instrument to supply its place in case of accident. No splinters, however, struck the building during the experiments.

On the second day of the experimental practice, the telegraph wire was carried on to the latrine of No. 70 tower, where a third station was formed. The range party retired to this tower during the practice, and this station was found very useful, as, owing to the very heavy storm of rain and wind, it was almost impossible to observe the signal flag at the battery, or to hear the bugle-calls.

The wire was carried on supports for the first 500 yards, as far as a dyke which crossed the range. This was considered advisable to allow free communication without injury to the wire, it being easier and quicker to carry the wire on supports

† This part of the programme was not carried out.

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than to bury it. The remainder of the line was merely laid on the shingle, as it was improbable that any persons would ride or walk over that portion of the ground during the experiments.

The supports used were tripods, formed of three hop-poles lashed together at the top with spun yarn, except at the Pevensey Road, which crossed the range in front of the battery, where, to allow of vehicles passing freely, two poles were erected, and the wire stretched between them, at a height of about 20 feet above the road. The wire was secured to the tripods at intervals, and to one of the poles, by taking a turn round them, so that, in case of accident to the wire, it should not all fall slack.

The wind was so excessively high, that, in some cases, it was necessary to secure the tripods to pickets driven into the ground, to prevent them from being blown over. They stood firmly, however, on the shingle.

The operation of preparing the tripods, setting up the poles, and stretching the wire, was commenced at 9.30 a.m., on Monday, 6th August, and completed at 5 p.m., on the same day, the distance between the two terminal stations being 1030 yards.

The earth connection at the tower station was difficult to make, owing to the porous nature of the shingle, which will retain no moisture. It was necessary to pour pails of water on the spot from time to time, after burying a few sods in the shingle round the metal.

At about 1 p.m. on Wednesday, 8th August, a shell burst at the muzzle of the 6-inch gun, and a splinter cut the telegraph wire near the road. The ends of the wire were, however, easily united, and communication restored in about five minutes.

About 120 messages were sent and received during the two days that the experiments were carried on.

On Thursday, the 9th August, the wire was rolled up on the drum, and the party returned to Chatham with the apparatus. The operation of rolling the wire up occupied 2½ hours.

The original intention was to have telegraphed up to the battery the range reports after the conclusion of each round (or two or three rounds); but, for several reasons, this was not fully carried out.

With the aid of a telescope, the Select Committee in the battery could see exactly where each shot struck, and could judge, with some degree of accuracy, its effects.

This the range party in No. 70 tower could not do, as they could not see the side of the tower fired at.

It became only necessary, therefore, to telegraph up the internal injury effected by the shot and shell, and the penetrations.

In order to discover where each particular shot or shell had struck the tower, the telegraph was exceedingly useful to the range party, as they were, by its means, able to obtain from the Committee the apparent effect of each discharge.

H. SCHAW, Captain, R.E.

August 20, 1860.

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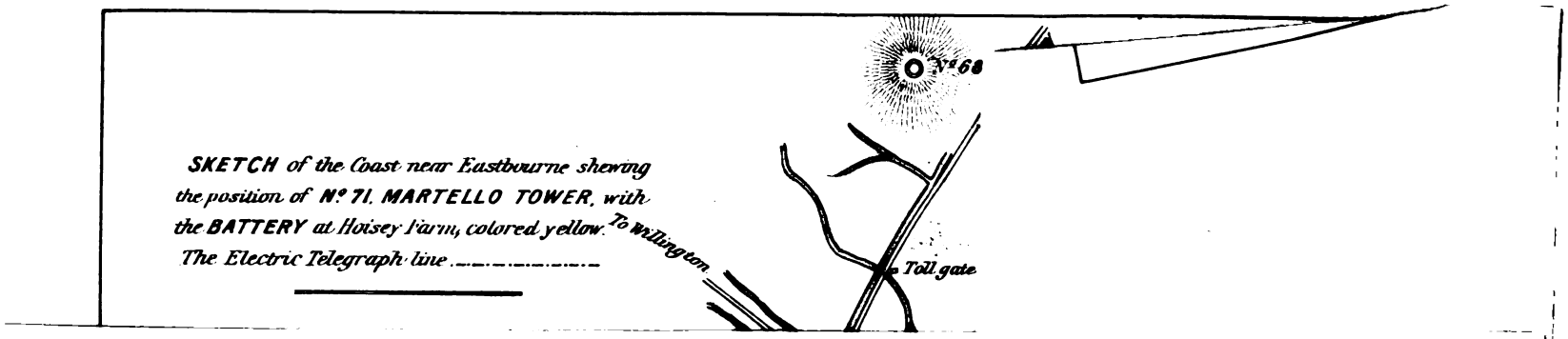

SKETCH of the Coast near Eastbourne shewing the position of **No 71. MARTELLO TOWER**, *with the* **BATTERY** *at Hoisey Farm, colored yellow. The Electric Telegraph line .....*

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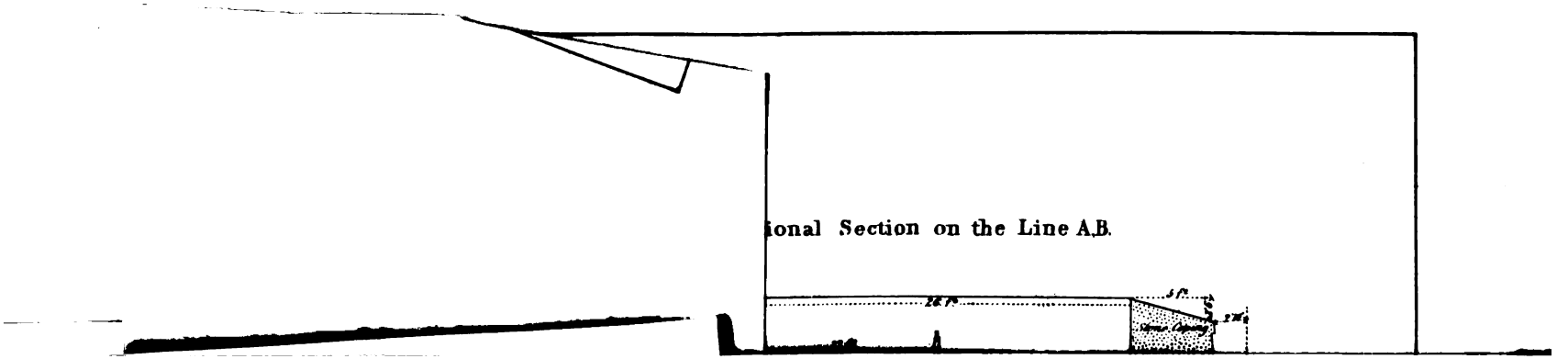

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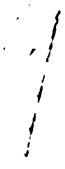

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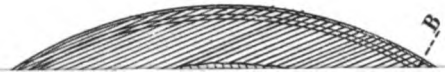
Shewing the portion rem

Plan of the top of the Tower.



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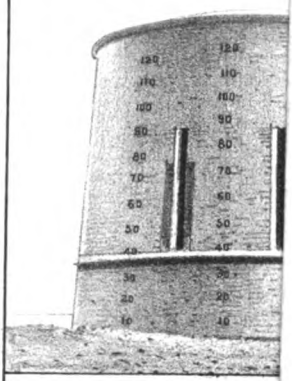

N°1. VIEW BEFORE THE COMM

H. Butler Pho: R.C.D. - J. Fergusso

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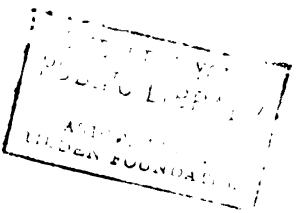

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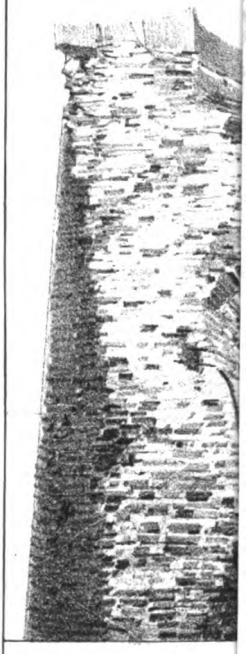

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H. Butler Pho. R.C.D. – J. Fergusso

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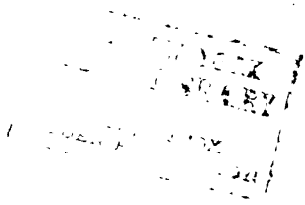

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